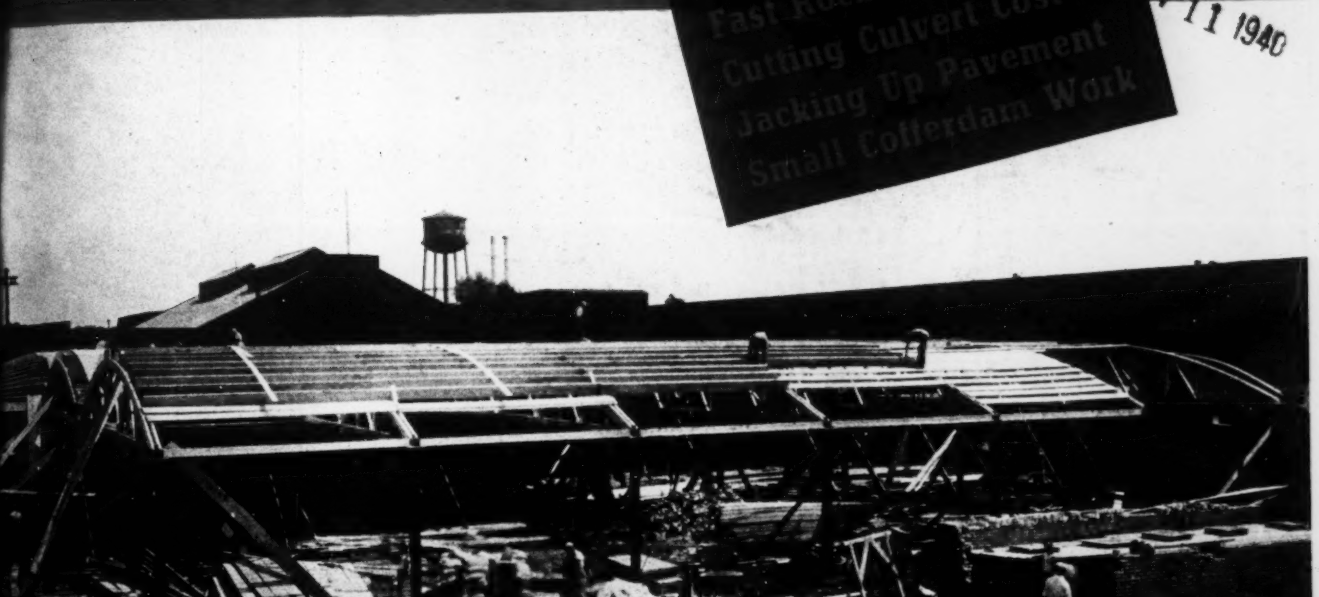
# ENGINEERING NEWS-RECORD

NOVEMBER 7, 1940

Fast Rock Tunneling
Cutting Culvert Cost
Jacking Up Pavement
Small Cofferdam Work

11 1940



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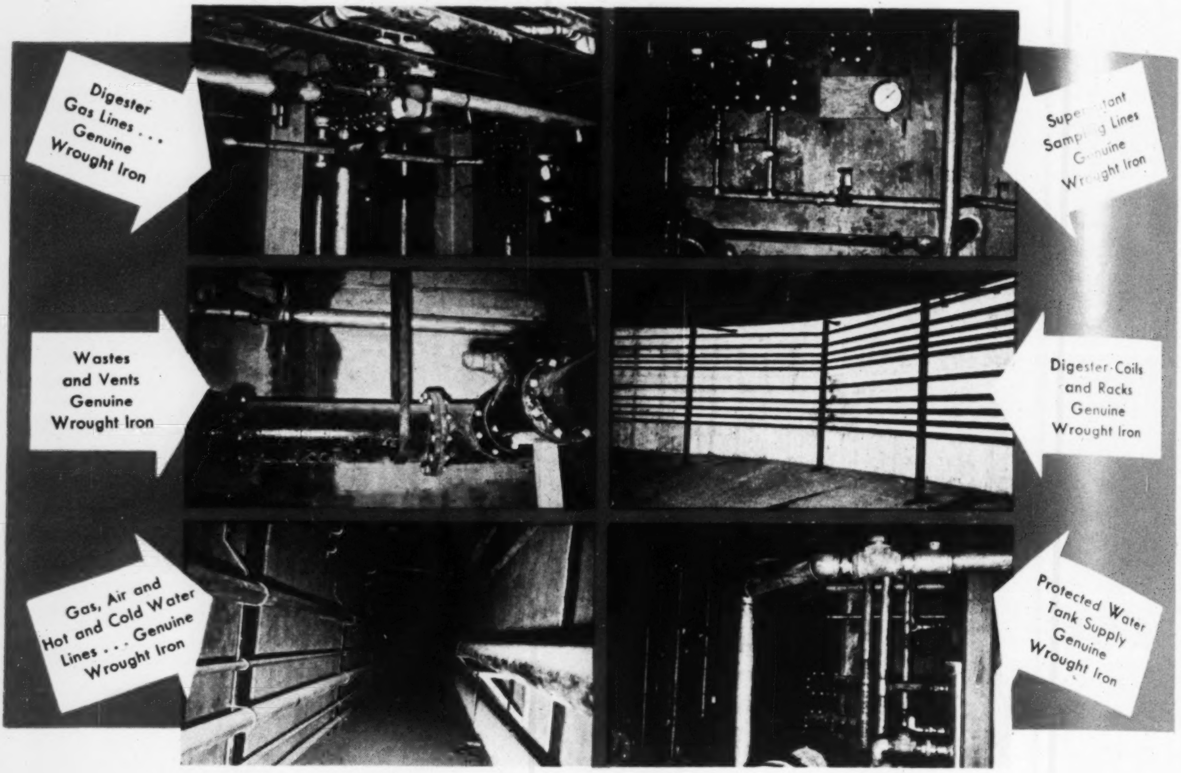
# CORROSION COSTS YOU MORE THAN WROUGHT IRON


Digester Gas Lines . . . Genuine Wrought Iron
Supernatant Sampling Lines Genuine Wrought Iron
Wastes and Vents Genuine Wrought Iron
Digester Coils and Racks Genuine Wrought Iron
Gas, Air and Hot and Cold Water Lines . . . Genuine Wrought Iron
Protected Water Tank Supply Genuine Wrought Iron

## For Corrosive Services in Sewage Plants

## THE BEST DEFENSE AGAINST EXCESSIVE MAINTENANCE

# BYERS WROUGHT IRON

The $743,000 sewage disposal plant at Marion, Ind., represents an investment of almost $30 for every man, woman and child in the city. Because excessive maintenance costs would naturally be immediately reflected in increased taxes, the Engineers—Consoer, Townsend & Quinlan—put particular emphasis on permanence and dependability in specifying materials. Byers Wrought Iron was installed in the nine services listed above, by the contractors, Stoehr, Laudon, Inc. General Contractors were Steigerwald and Borchert.

The trend toward more and better treatment in the modern sewage disposal plant increases the severity and the variety of the corrosion problems encountered. As recent specifications show, many designers are meeting this situation by an increased use of wrought iron . . . basing their selection on long-time service records drawn from personal or general experience.

If you are concerned with the selection of materials for corrosive sewage plant services in either new construction or in maintenance, our Engineering Service Department will be glad to provide you with data on the performance of wrought iron in similar applications. You will also find interesting discussions of corrosion problems, and information on how wrought iron is helping to solve them, in our bulletin, "Wrought Iron in Sanitary Systems." We will be glad to send you a complimentary copy.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

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**BYERS GENUINE WROUGHT IRON**
**TUBULAR AND FLAT ROLLED PRODUCTS**
**STEEL TUBULAR PRODUCTS**

# CONSTRUCTION TRENDS

**Notes on significant movements in the construction industry**

## Expanding industry for defense

THREE PRIMARY defense industries are spending $481,000,000 out of the total industrial building construction of $720,000,000 for the first 10 months of 1940.

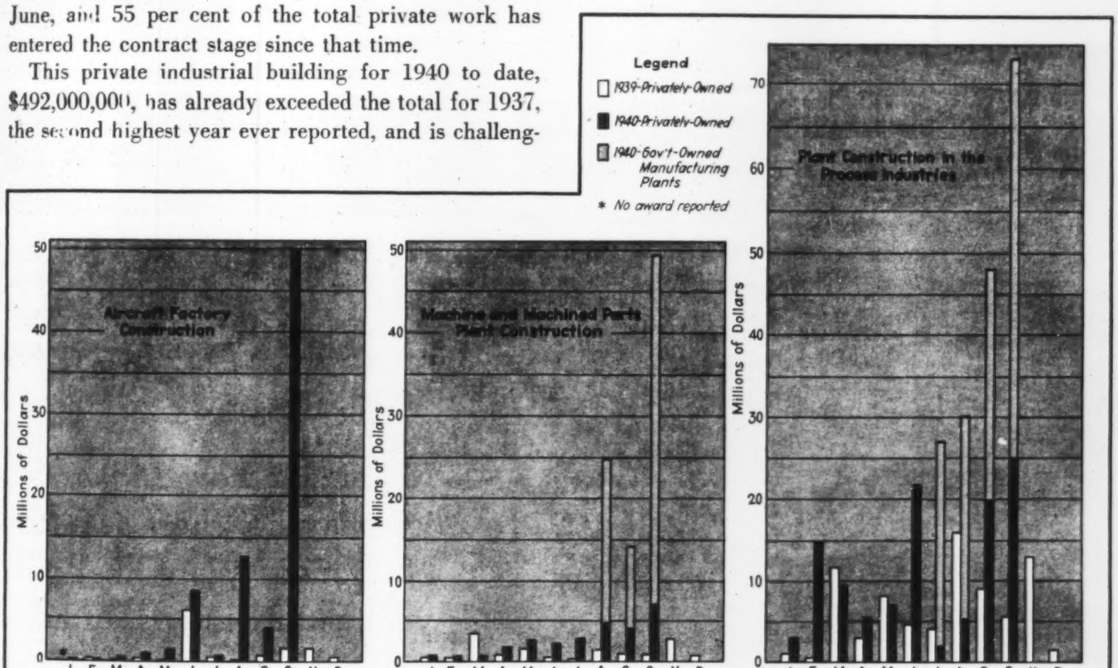
These are *aircraft*, $110,000,000 all privately owned and built plants; *process industry*, including powder plants, $252,000,000 of which $115,000,000 is privately-owned and built and $137,000,000 is War or Navy Department owned, but privately built; and *machine and machined parts plants*, $119,000,000, of which $30,000,000 is privately owned and built, $89,000,000 government owned but privately built.

Government-owned plants for manufacturing strategic war materials account for $226,452,000 of the 1940 10-month total. Private industrial building volume for the period is $492,000,000. All of the federally-owned plants have been put under contract since June, and 55 per cent of the total private work has entered the contract stage since that time.

This private industrial building for 1940 to date, $492,000,000, has already exceeded the total for 1937, the second highest year ever reported, and is challenging the record of $547,000,000 established in 1929.

Aircraft factory and process industry plant construction has surpassed all previous annual totals, and these, together with public utility and machine and machined parts plant buildings, which are potential record-breakers, are responsible for more than half of the private industrial building awards.

Of the government-owned plants, the $137,000,000 total is for manufacturing capacity for smokeless powder, ammunition loading plants and explosives factories in the process industries; and the $89,000,000 is for expansion and construction of shipbuilding plants, an armor plate factory, a tank plant, and shell forging and machining shops in the machine and machined parts manufacturing field.



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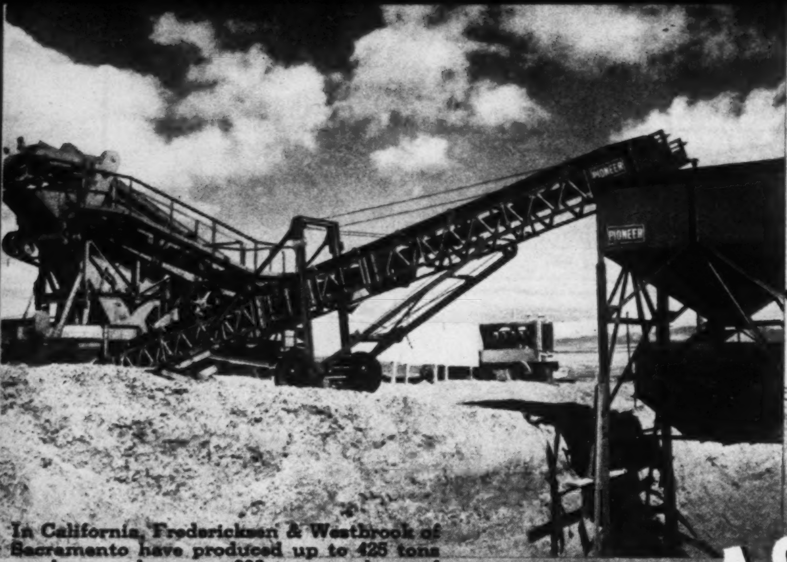
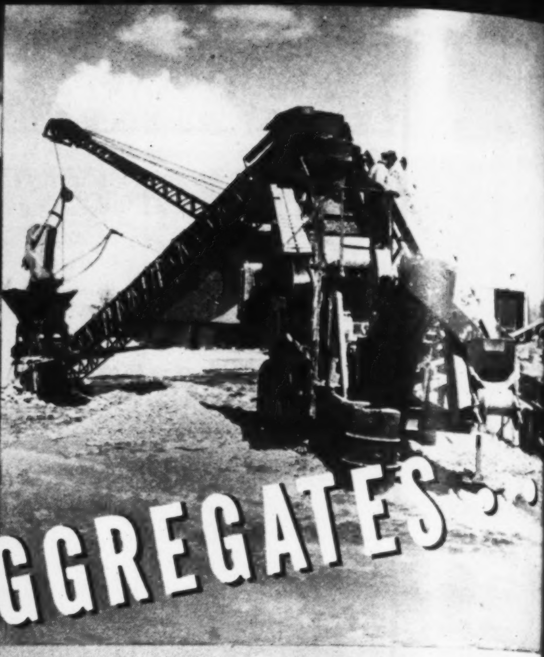
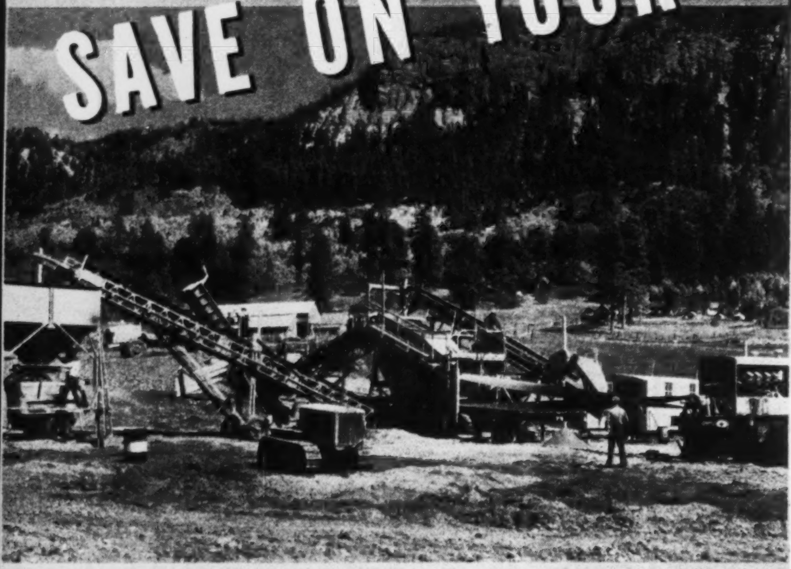


In California, Fredericksen & Westbrook of Sacramento have produced up to 425 tons per hour and average 300 tons per hour of gravel base course thru their Pioneer 48-V Plant.

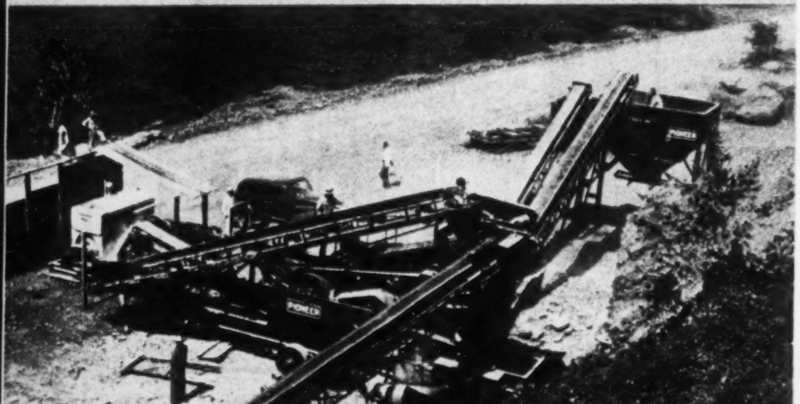


In Michigan, Harry Pickitt produces more material
less cost per ton in his Pioneer 38-V Duplex Plant.

# SAVE ON YOUR AGGREGATES . . .



In Colorado, Larson Construction Company of Denver save by producing their aggregate in a Pioneer 48-V Duplex Plant.



In Colombia, South America, they produce base course, stone chips and reject excess fines in their Pioneer 34-V Duplex Plant.

# WITH PIONEE

You, too, can save money by pr
ducing your aggregates in a Pione
Crushing, Screening and Loadin
Plant. Regardless where the job ma
be—California, Michigan, Colorad
or South America—Pioneer ca
help you.

No matter how big or small yo
job may be, there is a correct si
of Pioneer plant that will answ
your requirements. In addition, t
Pioneer plants will produce spe
fication material, reject any desir
percentage of fines and produ
stone chips simultaneously.

If you are interested in saving
your aggregates, write to

**PIONEER ENGINEERING WORKS, IN**
**MINNEAPOLIS, MINNESOTA**

# ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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**F. E. SCHMITT *and* WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager***

Vol. 125 NOVEMBER 7, 1940 No. 19

## THIS WEEK

• The demands upon the construction industry for speed and more speed to meet the nation's need for industrial plant expansion is being met by construction men with new ideas, new methods and an operating efficiency which is rapidly approaching a point of record. At least two such examples are set forth in this issue.

• In six weeks' time 36,000 sq.ft. of floor space was added to the Buda Co. plant for the production of diesel engines for the Army. And by coordinated erection methods a 30,000,000-lb. capacity aluminum plant was finished in six months, including excavation of site and erection of twelve large structures. Materials, methods and procedure are described.

• Construction speed records are not confined to the building industry alone. In driving the Carlton Tunnel in Colorado a world's record advance of 1,879 ft. from a single portal heading in a 31-day period is claimed. An average advance of 50 ft. per day was maintained month in month out. Turn to page 60.

## THINGS TO COME

• How hydraulic fill material pumped in to make the Washington National Airport was stabilized by using a small amount of binder and a large amount of mixing will be described in the Nov. 21 issue. The result was a cementless soil concrete surface 9 in. thick, having a minimum weight of 130 lb. per cu.ft.

• Chicago, proud possessor of the world's largest sewage disposal works, will secure its claim to this distinction by doubling the size of the Southwest plant. What will be done and how is the subject of an article that will appear in the next issue.

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*Number of copies of this issue printed: 34,924*

Over 2,000 tons of Ryerson Reinforcing Steel are being furnished R. C. Wieboldt Co., Chicago for the new Technological Institute at Northwestern University, Evanston, Illinois.

# Another Job Progresses "On Schedule" with Ryerson Reinforcing

Like thousands of other Contractors, the builders of Northwestern's new addition have learned by experience that Ryerson can be depended upon for prompt "on location" delivery of reinforcing bars and all accessories.

Ryerson offers a *complete* service to Contractors and Builders—a service that includes formed bars, wire mesh, caisson rings, removable forms and all accessories, as well as immediate stock shipment of uniform high quality steel products to meet every miscellaneous requirement. Bars are accurately cut, bent, formed, bundled, and tagged ready for the forms. Deliveries are coordinated with the progress of the work. There's no waiting for material when Ryerson handles the complete job.

Our special Contractors and Builders Division will be glad to work with you on your next job. Whether your problem is one of intricacy of design, large or small tonnage, special service, or limited time, a Ryerson engineer can probably save you time and money. On your next job get in touch with the Ryerson plant nearest you. JOSEPH T. RYERSON & SON, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Boston, Buffalo, Philadelphia, Jersey City.

**Ryerson Reinforcing Steel-Service Includes:**

NEW BILLET AND RAIL STEEL BARS AND ALL ACCESSORIES
WIRE MESH
REMOVABLE JOIST FLOOR FORMS
CAISSON RINGS
STEEL FLOOR JOISTS, BRIDGING AND ACCESSORIES
EXPANSION AND CONTRACTION JOINTS
STEEL SHEET PILING
METAL LATH AND ACCESSORIES
STRUCTURAL STEEL
BARS, PLATES, SHEETS, ETC.
WRITE FOR STOCK LIST.

RYERSON CERTIFIED STEELS

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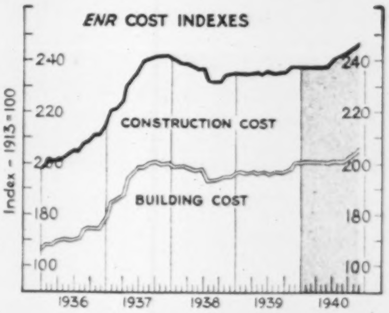
# MONTHLY CONSTRUCTION BUSINESS SUMMARY

## ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

| (,000 omitted) | October 1939 (4 wk.) | October 1940 (5 wk.) | % Change† | Ten Months 1939 (43 wk.) | Ten Months 1940 (44 wk.) | % Change† |
|---|---|---|---|---|---|---|
| Total Construction | $245,062 | $702,842 | +130.0 | $2,510,314 | $3,205,815 | +25.0 |
| Private Construction | 107,727 | 229,477 | +71.0 | 717,533 | 960,978 | +31.0 |
| Public Construction | 137,335 | 473,365 | +176.0 | 1,792,781 | 2,244,837 | +23.0 |
| Federal | 44,897 | 343,753 | +512.0 | 296,684 | 1,048,893 | +246.0 |
| Total New Productive Capital | $54,474 | $685,906 | +908.0 | $2,233,426 | $3,533,373 | +55.0 |
| Private Investment | 25,505 | 77,095 | +142.0 | 619,706 | 651,275 | +3.0 |
| Federal (non-federal work) | 28,969 | 77 | ........ | 485,692 | 600,137 | +21.0 |
| Federal (federal work) | ........ | 608,734 | ........ | 1,128,028 | 2,281,961 | +102.0 |
| FHA Mortgages Selected for Appraisal | $99,251 | $116,600* | +17.5 | $975,992 | $1,110,555* | +14.0 |

*†Adjusted for difference in number of weeks.* ** Preliminary.*



## CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

| | November 1939 | November 1940 | % Change | Change October to November 1939 Oct. | 1939 Nov. | % | 1940 Oct. | 1940 Nov. | % |
|---|---|---|---|---|---|---|---|---|---|
| *ENR* Construction Cost Index, 1913 = 100 | 238.20 | 247.24 | +3.8 | 236.86 | 238.20 | +0.6 | 245.02 | 247.24 | +0.9 |
| *ENR* Building Cost Index, 1913 = 100 | 201.24 | 206.24 | +2.5 | 198.50 | 201.24 | +1.4 | 204.02 | 206.24 | +1.1 |

### ENR 20-CITIES' AVERAGE

| | November 1939 | November 1940 | % Change | 1939 Oct. | 1939 Nov. | % | 1940 Oct. | 1940 Nov. | % |
|---|---|---|---|---|---|---|---|---|---|
| Common Labor | $0.685 | $0.711 | +3.8 | $0.685 | $0.685 | 0 | $0.711 | $0.711 | 0 |
| Skilled Labor (Av. 3 trades) | 1.463 | 1.480 | +1.2 | 1.444 | 1.463 | +1.3 | 1.480 | 1.480 | 0 |
| Bricklayers | 1.563 | 1.568 | +0.3 | 1.538 | 1.563 | +1.6 | 1.568 | 1.568 | 0 |
| Structural Ironworkers | 1.519 | 1.542 | +1.5 | 1.499 | 1.519 | +1.3 | 1.542 | 1.542 | 0 |
| Carpenters | 1.306 | 1.330 | +1.8 | 1.296 | 1.306 | +0.8 | 1.330 | 1.330 | 0 |
| Cement, per bbl | $2.60 | $2.54 | −2.3 | $2.60 | $2.60 | 0 | $2.52 | $2.54 | +0.8 |
| Reinforcing steel, cwt | 2.56 | 2.53 | −1.2 | 2.42 | 2.56 | +5.8 | 2.53 | 2.53 | 0 |
| Struct. steel, base price | 2.10 | 2.10 | 0 | 2.10 | 2.10 | 0 | 2.10 | 2.10 | 0 |
| Sand, per ton | 1.20 | 1.17 | −2.6 | 1.20 | 1.20 | 0 | 1.16 | 1.17 | +0.9 |
| Lumber, 2x4 Fir, per M ft. | 35.09 | 37.76 | +7.6 | 33.72 | 35.09 | +4.1 | 35.88 | 37.76 | +5.2 |
| Lumber, 2x4 Pine, per M ft. | 31.77 | 36.15 | +13.8 | 30.68 | 31.77 | +3.6 | 33.96 | 36.15 | +6.4 |
| Brick, common, per M | 14.39 | 14.44 | +0.3 | 14.22 | 14.39 | +1.2 | 14.43 | 14.44 | +0.1 |
| Ready-mixed concrete, c.y. | 7.10 | 6.94 | −2.3 | 7.10 | 7.10 | 0 | 6.94 | 6.94 | 0 |
| Struct. clay tile, 3x12x12 | 73.68 | 74.79 | +1.5 | 73.53 | 73.63 | +0.2 | 74.78 | 74.79 | ‡ |
| Paving asphalt, cars, ton | 13.77 | 14.21 | +3.2 | 13.77 | 13.77 | 0 | 14.21 | 14.21 | 0 |

*‡ Less than .05 per cent change.*

## ENR INDEX NUMBERS

| Base = 100 | Construction Cost 1913 | Construction Cost 1926 | Building Cost '13 | Building Cost '26 | Volume '13 | Volume '26 |
|---|---|---|---|---|---|---|
| Nov., 1940 | 247.24 | 118.85 | 206.24 | 111.49 | ... | |
| Oct., 1940 | 245.02 | 117.78 | 204.02 | 110.29 | 490 | 215 |
| Sept., 1940 | 244.13 | 117.35 | 203.13 | 109.83 | 324 | 142 |
| Aug., 1940 | 242.18 | 116.42 | 201.71 | 109.04 | 281 | 123 |
| July, 1940 | 242.15 | 116.40 | 201.68 | 109.02 | 308 | 135 |
| June, 1940 | 241.59 | 116.13 | 201.65 | 109.00 | 225 | 99 |
| May, 1940 | 238.86 | 114.82 | 201.17 | 108.75 | 201 | 88 |
| Apr., 1940 | 238.26 | 114.53 | 201.44 | 108.89 | 191 | 84 |
| Mar., 1940 | 238.29 | 114.55 | 201.47 | 108.91 | 162 | 71 |
| Feb., 1940 | 238.32 | 114.56 | 201.50 | 108.93 | 196 | 86 |
| Jan., 1940 | 238.34 | 114.57 | 201.52 | 108.94 | 173 | 76 |
| Dec., 1939 | 238.17 | 114.49 | 201.21 | 108.77 | 172 | 75 |
| Nov., 1939 | 238.20 | 114.50 | 201.24 | 108.78 | 219 | 96 |
| Oct., 1939 | 236.86 | 113.87 | 198.50 | 107.31 | 222 | 97 |
| 1939 (Av.) | 235.51 | 113.21 | 197.44 | 106.73 | 211 | 92 |
| 1938 (Av.) | 235.86 | 113.34 | 196.83 | 106.40 | 197 | 86 |
| 1937 (Av.) | 234.71 | 112.66 | 196.15 | 106.07 | 172 | 75 |
| 1936 (Av.) | 206.42 | 99.15 | 172.18 | 93.14 | 185 | 81 |

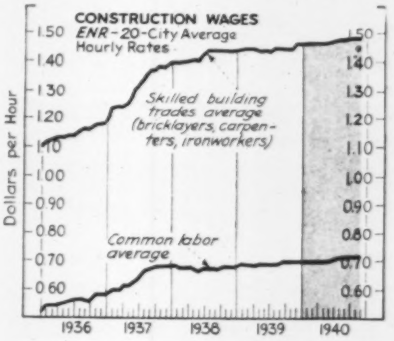
## MATERIAL SHIPMENTS . . . BUILDING PERMITS

| | October 1939 | October 1940 | % Change | Sept. 1940 | % Change Sept.-Oct. |
|---|---|---|---|---|---|
| Lumber (% 1929 wk. seas. av.) N. L. M. A | 79.0 | 85.5 | +8.2 | 85.5 | 0 |
| Steel (% operating capacity) A. I. S. I | 89.5 | 94.4 | +5.4 | 90.5 | +4.3 |

| | September 1939 | September 1940 | % Change | Nine Months 1939 | Nine Months 1940 | % Change |
|---|---|---|---|---|---|---|
| Fabricated Struct. Steel, tons A. I. S. C | 140,828 | 132,773 | −5.8 | 1,061,808 | 1,038,318 | −2.2 |
| Cement, thous. bbl., U. S. B. of M | 13,104 | 14,760 | +12.6 | 92,530 | 96,070 | +3.9 |
| Building Permits, Dun & Bradstreet (,000 omitted) | $103,204 | $118,952 | +15.3 | $945,157 | $1,009,425 | +6.8 |

## RENT INDEX . . . EMPLOYMENT

| | September 1939 | September 1940 | % Change | Aug. 1940 | % Change Aug.-Sept. |
|---|---|---|---|---|---|
| Rent (Housing) Index, N. I. C. B | 86.5 | 87.0 | +0.6 | 86.9 | +0.1 |
| Est. Total Employment, thous., N. I. C. B | 46,346 | 48,404 | +4.5 | 47,477 | +2.0 |
| Est. Construction Employment, thous., N. I. C. B | 2,235 | 2,658 | +19.0 | 2,590 | +2.7 |



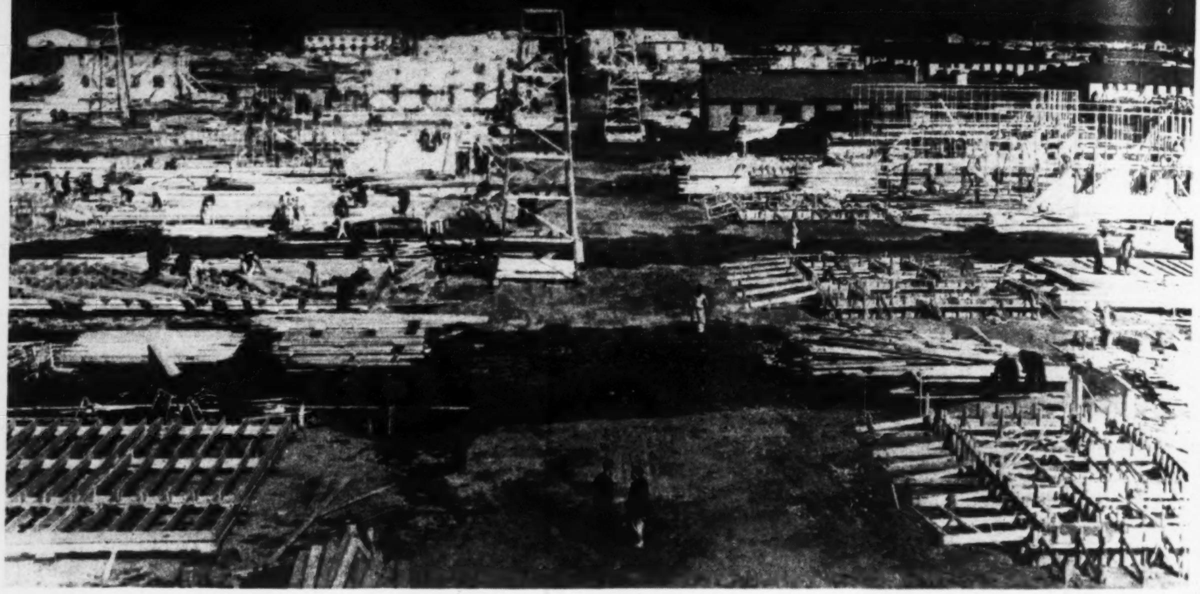
## ENGINEERING CONSTRUCTION CONTRACTS——ENGINEERING NEWS-RECORD——OCTOBER, 1940

Engineering News-Record *reports projects of the following minimum costs;— water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000 *industrial buildings,* $40,000; *other buildings,* $150,000

Five Weeks — Thousands of Dollars (000 Omitted)

| | New England | Middle Atlantic | South | Mid West | West of Mississippi | Far West | United States October 1940 | United States Ten Months 1940 | United States Ten Months 1939 | Canada |
|---|---|---|---|---|---|---|---|---|---|---|
| **Public Works** | | | | | | | | | | |
| Waterworks | 413 | 1,572 | 1,043 | 699 | 2,292 | 382 | **6,401** | 62,938 | 147,486 | 574 |
| Sewerage | 459 | 3,920 | 311 | 2,553 | 1,256 | 649 | **9,148** | 77,821 | 140,939 | 86 |
| Bridges, public | 1,970 | 4,150 | 2,311 | 999 | 1,639 | 591 | **11,660** | 94,932 | 123,755 | 280 |
| Earthwork and waterways | 435 | 2,673 | 1,882 | 246 | 1,334 | 2,026 | **8,596** | 205,329 | 204,097 | 59 |
| Streets and roads | 574 | 15,003 | 13,355 | 12,556 | 14,930 | 5,683 | **62,101** | 593,375 | 534,519 | 887 |
| Buildings, public | 16,475 | 70,563 | 48,361 | 52,411 | 48,478 | 43,510 | **279,798** | 821,782 | 497,604 | 15,325 |
| Unclassified, public | 16,140 | 24,074 | 26,403 | 1,860 | 6,551 | 20,633 | **95,661** | 388,660 | 144,381 | 1,144 |
| **Total public** | **36,466** | **121,955** | **93,666** | **71,324** | **76,480** | **73,474** | **473,365** | **2,244,837** | **1,792,781** | **18,355** |
| Federal government (included in above classifications) | 29,909 | 82,096 | 72,575 | 44,970 | 50,882 | 63,321 | **343,753** | 1,048,893 | 296,684 | ........ |
| **Private** | | | | | | | | | | |
| Bridges, private | ........ | 25 | ........ | ........ | 67 | ........ | **92** | 10,670 | 6,513 | ........ |
| Buildings, industrial | 7,916 | 17,314 | 30,765 | 70,170 | 14,631 | 13,695 | **154,491** | 492,084 | 220,820 | 1,274 |
| Buildings, commercial | 2,110 | 29,005 | 4,183 | 4,270 | 1,550 | 4,612 | **45,730** | 323,970 | 310,168 | 1,450 |
| Unclassified, private | 1,392 | 2,750 | 7,661 | 1,436 | 14,272 | 1,653 | **29,164** | 134,254 | 180,032 | 840 |
| **Total private** | **11,418** | **49,094** | **42,609** | **75,876** | **30,520** | **19,960** | **229,477** | **960,978** | **717,533** | **3,564** |
| **Total Engineering Construction** | | | | | | | | | | |
| **October, 1940 (5 weeks)** | **47,884** | **171,049** | **136,275** | **147,200** | **107,000** | **93,434** | **702,842** | .......... | .......... | **21,919** |
| September, 1940 (4 weeks) | 27,171 | 72,184 | 84,793 | 89,724 | 62,706 | 31,674 | **368,252** | .......... | .......... | 47,012 |
| October, 1939 (4 weeks) | 9,236 | 70,935 | 44,925 | 33,882 | 44,003 | 42,081 | **245,062** | .......... | .......... | 8,163 |
| Ten Months — 1940 | 212,087 | 749,145 | 692,721 | 616,598 | 546,028 | 389,236 | ........ | 3,205,815 | .......... | 226,683 |
| Ten Months — 1939 | 134,995 | 805,426 | 375,602 | 470,859 | 457,071 | 266,361 | ........ | .......... | 2,510,314 | 99,834 |

# *Concreting on the*
# DOUBLE-QUICK . . . MARCH!



## . . . Army Barracks at Camp Edwards, Mass., completed quicker with Atlas High-Early Cement!

EACH DAY 600 barrels of Atlas High-Early are being used for the concrete foundations to speed up construction at Camp Edwards. 1200 separate buildings, requiring 30,000 cu. yds. of concrete, will be completed by December, 1940.

On this project, like many others all over the country, engineers and contractors know they can depend on Atlas High-Early—the cement that gains working strength rapidly. It cuts time for protection and curing as much as 60—70%, often permitting earlier stripping and re-use of forms. But most important, it produces serviceable concrete in much less than the usual time.

Whether your next job is government or private, specify Atlas High-Early. For information, write Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Chrysler Bldg., N. Y. C.

**Offices:** *New York, Chicago, Phila., Boston, Albany, Pittsburgh, Cleveland, Minneapolis, Duluth, St. Louis, Kansas City, Des Moines, Birmingham, Waco.*

ENR-H-23

● **Atlas High-Early cement** speeds up **construction of Camp Edwards, United States Army Cantonment at Falmouth, Mass. General Contractors, Walsh Construction Co., Davenport, Iowa. Below:** Newly stripped **concrete foundation walls** of one of **the 1200 separate buildings** making **up the camp.**

**ATLAS HIGH-EARLY CEMENT**

**A UNIVERSAL ATLAS PRODUCT**

# The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • NOVEMBER 7, 1940

## Buildings Administration starts defense housing work

### Awards contract for 700-dwelling Ft. Knox project. Treasury Procurement Division pushes centralized purchasing of some materials

First of the new defense housing projects to be built under Public Buildings Administration supervision was put under contract last week at the Fort Knox, Ky., army reservation. The contract went to Fleisher Engineering and Construction Co., Lexington, on a cost-plus-fee contract estimated at $1,935,000. The project comprises 700 dwelling units in two-story, four and eight-unit, multiple dwellings. Buildings are of frame construction with clapboard or shiplap wall facing and composition shingles.

The project, one of those financed out of the $45,762,000 allocated by the Army to the Federal Works Agency, will be occupied by families of enlisted men.

#### Centralized purchasing pushed

Meanwhile, centralized purchasing of utility elements of houses in the program is being pushed. This is being handled for FWA by the Procurement Division of the Treasury. Specifications, very broadly worded, have been drafted on bathroom and kitchen units and every manufacturer in the field has been asked to submit bids on 1,000-unit lots; at the same time the manufacturers are being asked to supply information on capacity and storage facilities. Bids and filled-in questionnaires are now coming back. When these have been studied, the more promising bidders will be asked to submit quotations on 10,000-unit lots.

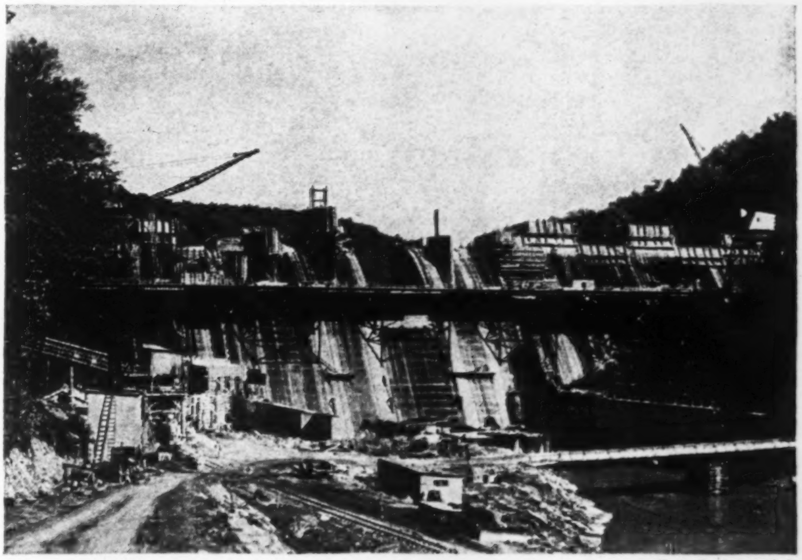
#### Large orders planned

It is not proposed to seek open-quantity contracts. Instead, items will be bought outright in lots of 1,000 or 10,000. If the maker has storage facilities he will be asked to store the product. If not, he can deliver to government warehouses. In either case, the items will be delivered to projects on requisition. Thus it is hoped the manufacturer can schedule production with least interference with his commercial orders and prices.

#### Prefabricated housing for San Diego

Centralized purchasing of prefabricated structural units (*ENR*, Oct. 24, p. 518) offers more difficulties because there is no existing industry capable of supplying prefabricated housing in quantity. Initially it is planned to give "educational orders" for ten to a hundred units to various of the firms in the field. If the resulting houses prove satisfactory and if the manufacturers are able to handle large orders Housing Coordinator Palmer would like to see nearly all the housing for industrial workers of a demountable type; this could run to as much as $150,000,000. Already, 1,000 units of demountable housing are scheduled for San Diego.

Possible solution of some of the difficulty in obtaining large numbers of units is hoped for in Washington as a result of reports that Budd—builder of streamlined trains—will enter the prefabricated housing field soon.



U. S. Engineers photo

**This dam will aid in preventing floods at Pittsburgh**

*Located on Mahoning Creek in northeastern Armstrong County, Pa., about 22 miles above the junction of that creek with the Allegheny River and about 50 miles northeast of Pittsburgh, this dam when complete will aid in reducing flood heights at Pittsburgh. The $6,870,000 project will provide permanent storage for 3,700 acre-ft. and 75,300 acre-ft. for flood control. When the reservoir is full a 2,275-acre lake extending about 19½ miles upstream from the dam will be created. The drainage area above the dam is 341 sq. miles.*

*Maximum flood at the dam site occurred March 18, 1936 with a peak discharge of about 22,800 cu. ft. per second.*

*The concrete gravity type structure will have a total top length of 993 ft. and a maximum height above stream bed of 160 ft.*

*Begun Feb. 3, 1939, the project is scheduled for completion in June, 1942.. Dravo Corp., Pittsburgh, with D. P. Childress as project engineer, is the general contractor. J. I. Bowman is resident engineer for the Pittsburgh District of the U. S. Engineers.*

## Association assessment on contractors held illegal

The system whereby contractors are required to pay one-fourth of one per cent of the gross amount of their contracts for the support of a contractors association is contrary to public policy and so unenforceable, according to the superior court of Pennsylvania. This decision was rendered by Judge Baldridge on Oct. 4, 1940, in sustaining a lower court in the case of the Constructors Association of Western Pennsylvania *vs.* Seeds and Derham.

In the case in question, the association sued the contractor for one-fourth of one per cent of the contract price of $877,000 for the erection of a dam across the Ohio River at Emsworth, Pa. for the U. S. government. The claim was based upon a by-law of the association, of which the defendants were members, which required all members to pay into the association treasury one-fourth of one per cent of all contracts obtained within the area.

At the trial, the association proved its claim. The defendant, without offering any evidence, asked for a directed verdict. The lower court granted the request on the ground that the by-law was invalid as contrary to public policy of the Commonwealth of Pennsylvania and therefore unenforceable.

Upon appeal, the decision of the lower court was sustained. A number of cases were cited in Pennsylvania and in other jurisdictions, including Kansas and Kentucky, all of which were to the effect that such a practice was invalid as contrary to public policy; that it stifled competition, although the number of bidders was not diminished, and that it increased the cost of public work.

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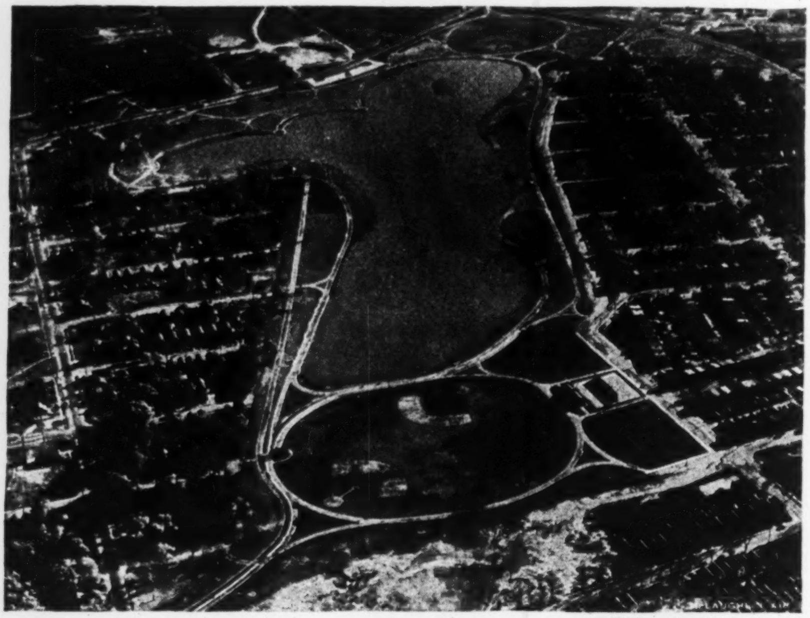
## Defense work delays North Carolina bridge repairs

North Carolina highway engineers are finding that the national defense program, by making it difficult to obtain necessary steel, is holding up the replacement of North Carolina bridges washed out during recent floods. C. B. Taylor, bridge maintenance engineer for the North Carolina State Highway and Public Works Commission, has announced that about 100 of the 600 bridges damaged or destroyed have not as yet been replaced with permanent structures.



McLaughlin Air Service photo

**Land fill disposal helped to make this park**

*Reconstruction of Baisley Pond Park in New York City, which was opened to the public on Oct. 30 by the department of parks, calls attention to the value of land fill refuse disposal in the development of recreational areas. At this place a 10-acre section of the park was filled with about 700,000 cu.yd. of mixed refuse in order to eliminate a deep, marshy hollow.*

*The work of filling the hollow with city wastes required only seven months, according to Albert J. Lizee, deputy commissioner in charge of land fills for the department of sanitation.*

*At the present time one-third of the New York City refuse is disposed of by land fill methods. Since the inauguration of this disposal system three years ago about 120 acres of otherwise useless land has been reclaimed annually.*

## Water chlorination part of Great Britain defense

The authorities responsible for the civil defense of Great Britain consider that there is risk that the water supplies may be contaminated by enemy action, and have issued instructions to waterworks that all supplies serving a population of 3,000 and upwards should now be continuously chlorinated in order to make them safe.

As this is written no instructions have been issued regarding the water supplies of the smaller communities, according to *The Surveyor*, British engineering journal.

In this connection it is interesting to note that only about one-third of the 12,750 waterworks systems in the United States now provide chlorination, according to the *Engineering News-Record* inventory of water supply facilities.

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## Washington Bridge firm loses in damage case

The U. S. District Court at Tacoma, Wash. has denied the Wauna Toll Bridge Co., operators of the "Bridge of the Gods" over the Columbia river, $45,000 damages sought in connection with the raising of the bridge 45 ft. to provide clearance above the Bonneville Dam reservoir (*ENR*, Oct. 10, 1940, p. 461). The cost of the raising work was paid by the government, but the bridge company contended that it should receive pay for: increased maintenance costs, loss of tolls during the time the bridge was being raised, operating a ferry during reconstruction work, and easement of land now flooded.

The government maintained the condemnation of the flooded land had no connection with raising of the bridge but resulted from the construction of Bonneville Dam, which is about four miles downstream.

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## Mississippi River span made toll free

The Mark Twain Bridge across the Mississippi River connecting Pittsfield, Ill. and Hannibal, Mo. has been made toll free. The bridge, which carries traffic of U. S. Highway 36, was officially opened to traffic Sept. 4, 1936. Since that time sufficient has been collected in tolls to retire the $300,000 indebtedness on the million dollar structure.

The Illinois State Highway Department and the Missouri State Highway Department built the approaches, and the city of Hannibal, Mo. the bridge proper with a $300,000 bond issue and a grant from the Public Works Administration.

## Plans nearing completion for defense training

First courses to be offered under the $9,000,000 federal program of college-grade defense training will be designed to produce inspectors of materials, chemicals, instruments and engines; designers of machinery, tools and dies, and aircraft instruments, structures and equipment; production engineers and supervisors; physical metallurgists; marine engineers; and naval architects. Schools to offer the courses have not yet been definitely selected, but an announcement is expected in mid-November.

Detailed administration of the program will rest with 22 newly selected regional advisors. All college professors, each of these men in his own region will maintain contact on the one hand with the engineering schools and on the other with defense industries, Army and Navy offices, and employment agencies. Their reports to Washington will be the means of keeping the program coordinated nationally.

The courses, of college grade but aimed at immediate practical application, will be available without tuition to men who have had some technical training or equivalent practical experience. Classes will be held at both the engineering schools and, for the benefit of evening students, at nearby industrial plants. Placing graduates of the courses in defense jobs will be handled mainly by contact between the colleges and industry and also through state and federal employment services and the U. S. Civil Service Commission.

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## RFC seeks judgment against 2 Kentucky towns

Stating that the towns of Eddyville in Lyon County, Ky., and La Center in Ballard County, Ky., defaulted on maturities on bond issues sold in 1934 for the construction of municipal water systems, the Reconstruction Finance Corp. has asked judgment totaling $10,280 against the two towns. The suits were filed in the United States district court at Paducah, Ky. The federal judge was also requested to appoint a receiver for the Eddyville waterworks.

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## Additional flood control planned for Ohio River

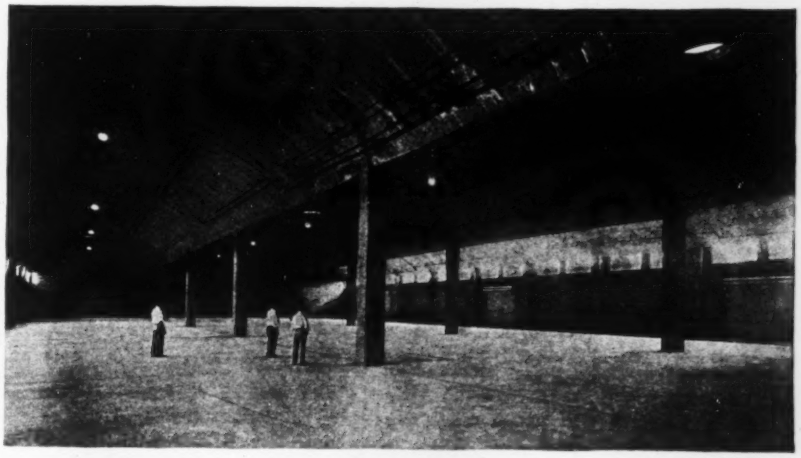
Bids will be asked by the U. S. Engineer Corps, before the first of the year, for construction of the Youghiogheny River Reservoir Dam at Confluence, Pa., according to Lieut. Col. L. D. Worsham, district engineer at Pittsburgh. This dam is the sixth in a series of ten in the reservoir system planned to protect Pittsburgh and reduce flood heights in the upper Ohio Valley.

Cost of the entire project, including all land and flood easements, is estimated at $9,000,000, which is to be borne entirely by the federal government.

The dam will be of the earth-fill type, 184 ft. from stream bed to crest with a top length of 1,600 ft.

## Penn Turnpike tolls $140,000 in 15 days

Reporting on the first half month of operation of the Pennsylvania Turnpike, the Pennsylvania Turnpike Commission has made known that during the first 15 days of public use of the superhighway more than $140,000 was received in tolls. During the period the road carried more than 150,000 automobiles and about half a million passengers.



Dementi photo

## Richmond completes new deep water terminal

*With the city of Richmond, Va., the Public Works Administration, the Work Projects Administration and the Virginia State Highway Department having spent a combined total of about $3,526,000, a new terminal has been completed for the city of Richmond on the James River 3.8 miles below the city's present corporate limits. Since 1930 the War Department has spent $3,434,000 for improvement of the 87 miles of the river between the terminal and the Atlantic Ocean. From the river's mouth to Hopewell, Va., a distance of 69 miles, a channel depth of 25 ft. below mean low water with a bottom width of 300 ft. is now provided.*

*From the city of Hopewell to the new terminal, a distance of 18 miles, the channel has been dredged to provide a depth of 25 ft. with a bottom width of 200 ft. The new terminal, known as the Deep Water Terminal, also has a turning basin with a bottom width of 700 ft., a depth of 25 ft., and an overall length of about 1,600 ft.*

*Facilities at the new terminal consist of a concrete wharf 1,250 ft. long, two concrete warehouses and 15,000 sq. ft. of shed.*

*The upper photo shows an aerial view of the new terminal, which is on the west side of the river; the lower view shows arch-roofed construction for one of the warehouses.*

# JOBS OF THE WEEK

**ARMY CANTONMENT, Fort Riley, Kan.**
Manhattan Construction Co., Oklahoma City, Okla., M. W. Watson, Topeka, and Long Construction Co., Kansas City, Mo. were awarded a joint $7,060,000 contract on a cost-plus-fixed-fee basis for constructing the army cantonment at Fort Riley for the War Department, Washington, D. C.

**HOUSING PROJECT, Kittery, Maine.**
J. Slotnik Company, Boston, Mass., will construct the brick housing at the Portsmouth Navy Yard for the Bureau of Yards & Docks, Navy Department, Washington, D. C., under terms of a $2,308,250 contract.

**HOUSING, Indianhead, Md.**
Harwood Nebel Construction Co., Inc., Washington, D. C., is constructing additional ammunition facilities and low-cost naval housing for the Bureau of Yards & Docks, Navy Department, under terms of a $1,945,000 contract.

**FACTORY, York, Pa.**
Cummins Construction Corp., Baltimore, Md. received the contract from York Safe & Lock Co., York, Pa., for constructing a 2-unit plant on a 197-acre site north of York, Pa., to manufacture national defense materials. The project is estimated to cost $1,700,000 with equipment.

**BULKHEAD WALL, New York, N. Y.**
Nicholas Di Menna & Sons, Inc., New York, N. Y., was awarded a $1,110,615 contract for a bulkhead, wall, sewer and fill along Marginal St. (East River Drive) from East 36th to East 41st Sts. The president of the Borough of Manhattan, Municipal Bldg., New York City, is doing the work, which is over the site of the new 38th St. vehicular tunnel.

**SUBMARINE BASE FACILITIES, Key West, Fla.**
W. P. Thurston Co., Richmond, Va., was awarded a $923,000 contract on a cost-plus-fixed-fee basis for rehabilitation of the submarine base facilities and constructing a marine railway at the Naval Station, Key West.

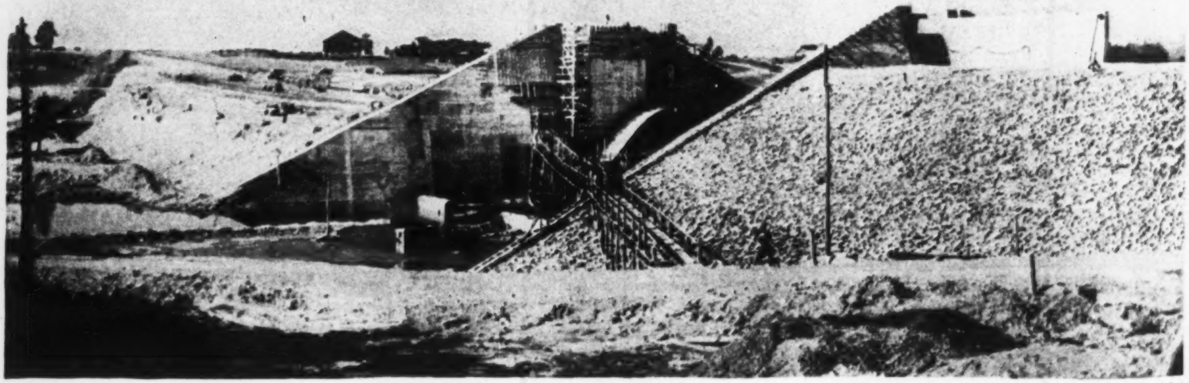
**HOUSING, Charleston, S. C.**
Southeastern Construction Co., Charlotte, N. C. will construct the housing facilities at the Navy Yard, Charleston, for Bureau of Yards & Docks, Navy Department, Washington, D. C., under terms of a $525,000 contract.

NOTE—Additional bidding and contract news on over 800 projects, large and small, appear in the Construction News Section beginning on page 121.

## St. Louis union fight includes strike of 10,000

A labor dispute that flared up in St. Louis two weeks ago threatened to break out into warfare between CIO and AFL for control of formerly unorganized building contractors and suburban development operators in the city of St. Louis and surrounding St. Louis county. On Oct. 22, AFL organizers warned workmen employed by Schuermann Building and Realty Co., which was operating as open shop, not to report for work the next day. The 300 workers on one project ignored the warning and on Oct. 23 battled with 50 AFL pickets killing one and badly hurting four others. AFL immediately called a general strike involving 10,000 building tradesmen who were out until the morning of Oct. 29 when all returned to work.

Contractors claim the general strike is not a violation of their labor agreement and that the strikers cooperated in closing down jobs without damage to concrete pours and similar work under way. Meanwhile CIO, long inactive in St. Louis, jumped in and organized the remaining three large realty development contractors. Now both CIO and AFL are trying to organize the 50 small contractors belonging to the Builders Guild, formerly open shop. AFL is reported to be threatening another general strike to fight off CIO if latter has any success. Right now everything is peaceful, but contractors fear an explosion any minute. Wage scales and working conditions are not involved.



*R. F. Legget photo*

## Eastern Canada's first major flood-control dam nears completion

*Shand Dam on the Grand River near Fergus, Ont. about 70 miles west of Toronto is nearing completion as eastern Canada's first major flood-control structure. The concrete spillway section is almost finished; the east earth fill shown in the foreground is about 14 ft. from the top; and the west fill is about 50 percent complete. The above view shows the downstream face of the dam, which will be 75 ft. high. The embankment will contain 500,000 cu. yd. of earth fill.*

*Progress on the structure has been hampered by one of the wettest summers on record in Ontario. The work, financed jointly by the federal, provincial and local municipal governments, was started last November by the Rayner Construction Co., Ltd., Toronto (ENR Nov. 30, 1939, p. 726). H. C. Acres, consulting engineer of Niagara Falls, Ont., is chief engineer for the Grand River Conservation Commission, the owners.*

# BRIEF NEWS

To STIMULATE construction the federal government of Uruguay has passed necessary legislation to provide that all buildings placed under construction before Dec. 31, 1943, will be tax exempt for ten years. The exemption will date from the time of completion of the work.

ALTHOUGH travel on the Illinois highway system has increased from 991,000,000 to 1,456,000,000 miles monthly during the past ten years, the state's highway fatality rate has decreased from 19 to 12 deaths per 100,000,000 miles, according to Illinois state safety engineers.

LEGAL RESTRICTIONS have been removed by the Arizona state legislature to permit the city of Flagstaff to double its present potential water supply of 100,000,000 gallons per day. The work involves a dam across Lake Mary and a nine-mile pipe line.

A TOTAL of 4,427 professional engineers, of which 2,178 are civil engineers, has been registered in the state of Texas since the Texas general assembly passed legislating setting up the Texas State Board of Registration for Professional Engineers, according to the board's first report filed recently with Governor O'Daniel. This report further pointed out that one out of five applications had been rejected since 5,507 applications were filed for registry. Registrants classified in two or more divisions number 497.

ALABAMA'S 1939-40 highway repair bill has been placed by Highway Director Chris J. Sherlock at about $800,000. This includes the unusual damage due to last winter's unprecedented snowfall.

CASH FARES have been reduced from 25 to 20 cents on the municipal bridge at Louisville, Ky. In addition a new type of ticket providing six passages for $1 has been authorized by the Louisville Bridge Commission, owner of the structure.

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## Road fund transfer halted in South Carolina

The South Carolina State Supreme Court last month held unconstitutional a part of that state's 1940-41 general appropriations bill which would have appropriated $2,000,000 in highway funds for general state purposes. The court held that the section of the act under contest "contravenes" constitutional limitations on the uses of highway revenues.

This is the second time in two years that the state legislature's attempts to divert highway funds were prevented by the state's highest court, the first concerning the 1939-40 diversion act.

The court pointed out that "under each act the stated purpose and the sole object of the legislation is to divert part of the proceeds of the five cents gasoline tax and motor vehicle license revenue fees to the state deficit and payment of state expenses. . . .

"What the 1940 act does is to appropriate tax money that was levied prior to legislation. Therefore, in the present case we are dealing with a statute that disregards the constitutional requirement of levying a tax, and in its stead appropriates a tax money which had been previously levied and appropriated. This tax money is not a part of the general funds of the state."

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## Milwaukee filtration plant closed to public

The Milwaukee filtration plant and the North Point and Riverside pumping stations have been closed to the public by orders of Henry P. Bohmann, superintendent of waterworks at Milwaukee, as a precautionary measure against possible sabotage. The filtration plant was opened 18 months ago and some 37,000 visitors have inspected it since that time.

The city has no plans at this time for closing its sewage disposal plant to the public.

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## Road to top of Mt. Mitchell approved in No. Carolina

Plans of the North Carolina State Highway and Public Works Commission to construct a road connecting the summit of Mount Mitchell in western North Carolina with the Blue Ridge Parkway have been approved by the North Carolina Board of Conservation and Development. The road, to be about 4½ miles long, will link the parkway with the highest peak east of the Rockies. It is expected that the highway will be ready for travel by next summer.

**Rapid advancement on Springfield, Ill. housing work**

*Work on this Springfield, Ill., housing job, the John Hay Homes project to provide 599 units of from 3 to 6½ rooms each, was begun Aug. 7. Already demolition of existing buildings on the nine city blocks is 95 percent complete and construction work under way on many of the 57 buildings to be constructed.*

*Ninety percent of the bonds issued to finance the project, which is estimated to cost between $2,600,000 and $2,860,000, are to be taken by the federal government's USHA at 3½ percent, and the remaining 10 percent are to be sold a year from now by the Springfield Housing Authority, the owners.*

*The two-story brick and concrete buildings will have concrete floors with wood used only for roof, doors and windows. A central steam heating plant will be constructed, and a contract has been awarded to the Springfield city water, light and power department for water and electricity—all cooking to be done by electricity and the electric rate to be based on a sliding scale depending on the price of coal.*

*Palmer School, the two-story structure shown at the left, will remain standing in the center of the project.*

*E. C. Worthington is representing the USHA on the work. Associate Architects of Springfield, with Carl Meyer as chief architect and Harry Reigher architect on the job, are architects for the work. Orie Callback is representing the general contractor, John Felmly Co., Bloomington, Ill.*

# OBITUARY

**Charles Allen Mize**, 67, retired civil engineer who served as provincial superintendent of education in engineering for the Philippine Islands after appointment by President Taft, died at Athens, Ga. Oct. 27. A resident of Athens since 1928, he was for many years city engineer of Commerce.

**Donald Rankin**, southern California construction engineer, died Oct. 22 in Covina, Calif. Rankin had played an important part in the series of tunnels recently completed for the Metropolitan Water District of Southern California and until very recently had been in charge of work on the Shasta tunnels on the new line of the Southern Pacific.

**Byron K. Coghland**, 59, PWA inspector on the Chicago South District filtration plant, died Oct. 27 in Kankakee, Ill. A major during the World War, Coghland at one time served as instructor in engineering at the New Mexico School of Mines and at Texas A. & M. College.

**Walter Peck Chapman**, 83, railroad and bridge engineer who retired many years ago, died in Toronto, Ont., Oct. 25. Chapman went to Canada from England in 1882 to enter railroad work the following year. He spent some years with the Canadian Pacific, then joined the Grand Trunk Ry., and later worked with Mackenzie & Mann on railway construction.

**Leonard Gibson**, 54, civil engineer, died in Montreal, Ont., Oct. 23. For nearly 31 years he was an employee of the Canadian National Railways and the Grand Trunk Ry.

**Charles M'Lean Murray**, 55, civilian naval architect with the U. S. Army Engineers at Philadelphia, died in Philadelphia last week. Murray had worked in Washington, D. C. for 20 years before being transferred to Philadelphia a year ago.

**William E. Turner**, 60, official surveyor of Lauderdale County, Ala. for the past 25 years, died last week at Killen, Ala.

**James T. Aston**, 81, retired chief inspector of the bureau of engineering of the city of Pittsburgh, died Oct. 23. He was employed by the city for 35 years, having retired ten years ago.

**Irvine Dibblee**, 64, contractor who formed the firm of McDonnell & Dibblee and later the Dibblee Construction Co., Ltd., Ottawa, died in Montreal, Ont., Oct. 23.

**Frank A. Poole**, 56, head of the National Construction Co. and a widely known general contractor, died Oct. 28 in Cleveland.

# CONTRACTS AND CAPITAL

**Engineering construction** awards for the short week due to the Election Day holiday total $79,645,000, 57 per cent higher than in the corresponding 1939 week. This is the tenth consecutive week that current awards have topped their respective 1939 weekly values.

Private construction is 11 per cent higher than in the week a year ago, and public tops last year by 89 per cent.

The current week's awards bring 1940 construction to $3,285,460,000, 26 per cent above the volume for the 45-week period last year. Private construction is 30 per cent higher than in 1939, and public work is 24 per cent greater than last year as a result of the 250 per cent gain in federal construction.

New capital for construction purposes for the week totals $49,420,000, an increase of 303 per cent over the volume reported for the corresponding 1939 week. This week's new financing is made up of $38,239,000 in USHA loans for low-cost slum-clearance projects, $9,691,000 in state and municipal bonds, $1,480,000 in corporate security issues, and $10,000 in RFC loans.

### CONTRACTS

(Thousands of dollars)

| | Week Ending | | |
|---|---|---|---|
| | Nov. 9 1939 | Oct. 31 1940 | Nov. 7 1940 |
| Federal | $5,725 | $53,533 | $34,461 |
| State & Municipal | 24,402 | 27,114 | 22,539 |
| Total public | $30,127 | $80,647 | $57,000 |
| Total private | 20,476 | 77,107 | 22,645 |
| TOTALS | $50,603 | $157,754 | $79,645 |

Cumulative
1940......(45 weeks)....$3,285,460
1939......(45 weeks)....$2,610,957

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

### NEW PRODUCTIVE CAPITAL

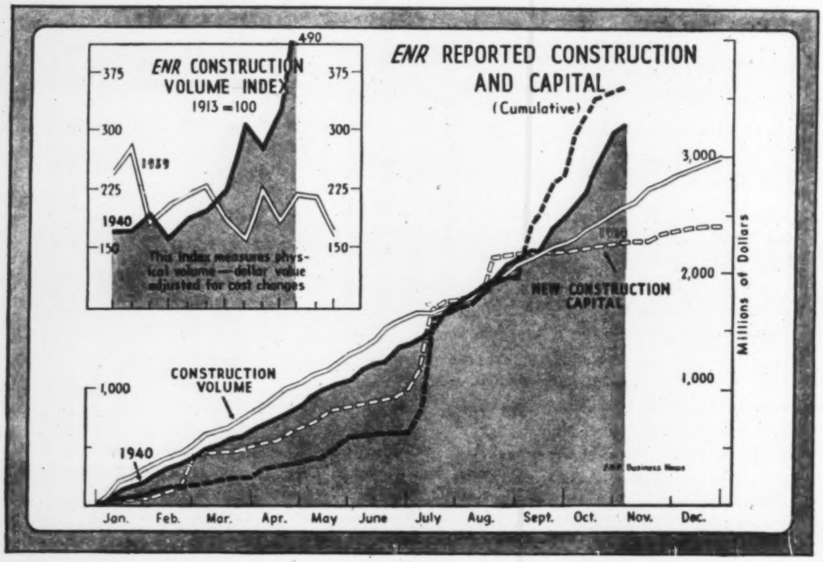
| | Cumulative | |
|---|---|---|
| | 1939 45 Wks. | 1940 45 Wks. |
| NON-FEDERAL | $1,135,239 | $1,300,832 |
| Corp. Securities | 193,519 | 216,410 |
| State & Mun. | 452,783 | 446,036 |
| R.E.A. loans | 89,445 | 40,000 |
| U.S.H.A. loans | 201,647 | 218,704 |
| R.F.C. loans | 7,854 | 195,682 |
| Fed. Aid-Hwy | 190,000 | 184,000 |
| FEDERAL | $1,128,028 | $2,281,961 |
| TOTAL CAPITAL | $2,263,267 | $3,582,793 |

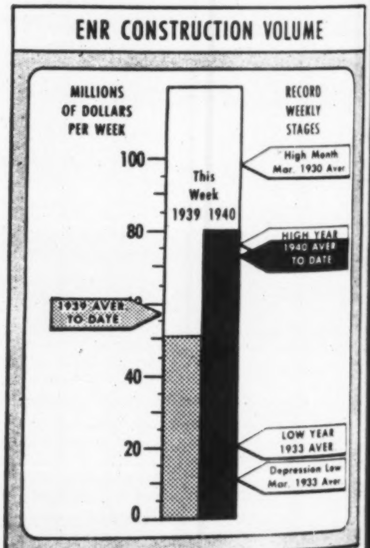
### FHA MORTGAGES

| | Week Ending | | |
|---|---|---|---|
| | Nov. 4 1939 | Oct. 26 1940 | Nov. 2 1940 |
| Selected for appraisal | $20,392 | $26,640 | $18,728* |

Cumulative
1940.....(44 weeks)....$1,108,675*
1939.....(44 weeks)....$1,115,447*

* Subject to revision.





## Preliminary studies begun for St. Lawrence dam

Representatives of the Canadian and United States governments met Oct. 31 at Messina, N. Y., to start the preliminary studies for construction of a power dam across the St. Lawrence River near that point. Such studies were authorized by the two governments earlier in October, President Roosevelt having allocated $1,000,000 of defense funds towards cost of the work.

The project under study is for a single-stage development at the Barnhart Island site, which is about midway between Massena, N. Y. and Cornwall, Ont. The main dam and powerhouses would be built at that point and a low dam would be built at the head of the International Rapids to control the levels of Lake Ontario. About 2,000,000 hp. could be developed at that site in a powerhouse located across the international boundary. The cost is estimated at $235,000,000.

The United States committee consists of Leland Olds, chairman of the Federal Power Commission; A. A. Berle, Jr., Assistant Secretary of State; Brig. Gen. Thomas M. Robins, Assistant Chief of Engineers, U. S. Army; and Gerald V. Cruise, executive secretary, New York State Power Authority.

The Canadian committee consists of Guy A. Lindsay, engineer in charge of general engineering, Department of Transport; Thomas H. Hogg, chairman, Hydro-Electric Power Commission of Ontario; Olivier LeFebvre, vice-chairman, Quebec Electricity Board; and J. E. Read, legal adviser, Department of External Affairs. All members of the two commissions except Read and Berle are engineers.

As noted in these pages last week, the U. S. Engineer Department has set up a St. Lawrence River District with Lt. Col. A. B. Jones in charge to make the borings and surveys required for a new report on power development in the International Rapids.

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## Control of ground water in Texas is proposed

State legislation to put usage of underground water in the state of Texas under the same regulation and control as surface waters was proposed at a recent meeting at Austin of the Texas Watersheds Association with the Texas State Board of Water Engineers. The suggestion was prompted by an alarming drop in Texas water tables. A committee of five was appointed to draft a proposed bill, which will be submitted for approval at a meeting with the National Resources Planning Board, Nov. 12-13 at Austin.

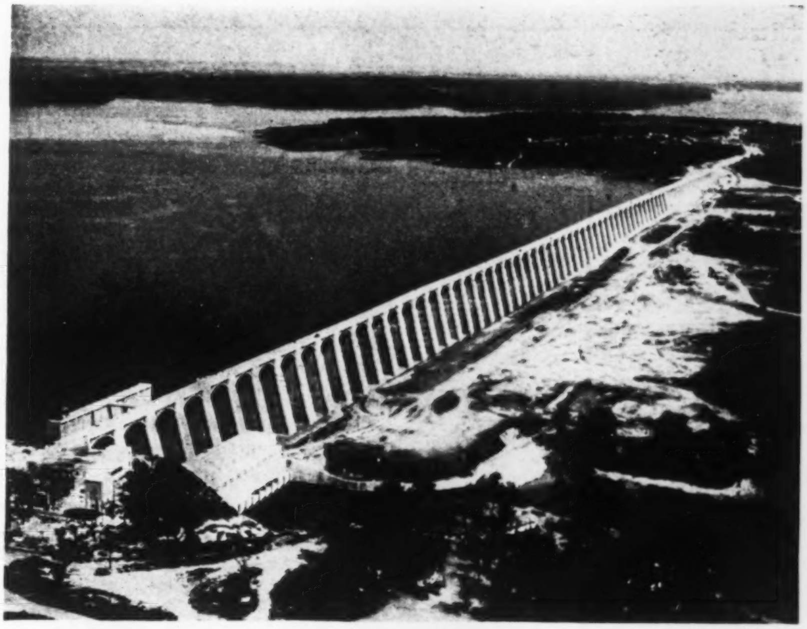

Photo by Bob White

## World's largest multiple arch dam completed

*Late last month Holway & Neuffer, consulting engineers of Tulsa and Albuquerque, accepted as complete for the Grand River Dam Authority the $22,500,000 Pensacola Dam — largest structure of its type in the world. Consisting of 51 arch sections, each of 60-ft. span between hollow buttresses to make the total length of the arch section 4,284 ft., the dam is the hydro-electric and flood-control project in northeastern Oklahoma on the Grand River that Governor Phillips of Oklahoma tried without success to halt last March when he ordered out the National Guard.*

*The drainage area in Oklahoma, Kansas, and Missouri above Pensacola Dam, which is 152 ft. in maximum height with a 20-ft. roadway and a 4-ft. sidewalk along its crest, totals 10,415 sq.mi. When the upper pool reaches El. 745, a 46,000-acre lake providing for 1,680,000 acre-feet of storage will result. When the above photograph was taken the upper pool was at El. 721.1 ft. and the lake above the dam covered 28,000 acres. Largest flood on record at the dam site is 215,000 cfs; a total spillway capacity of 525,000 cfs has been provided.*

*Final efficiency tests on the generators are in process. On Oct. 30 Oklahoma Gas & Electric Co. contracted for 25 percent of the power to be produced at a rate of 3.2 mills per kilowatt-hour.*

*Massman Construction Co., Kansas City, with R. G. Stowell, construction superintendent, was the general contractor. The Public Works Administration, which provided a $20,000,000 loan for the project, was represented by Lester M. Marx and Floyd Conway as project and resident engineer, respectively. Victor H. Cochrane was design engineer for Holway & Neuffer and Lee Hendrix chief construction engineer.*

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## More power sold from Bonneville Dam

A contract for sale of an additional 97,500 kw. of power from the Bonneville Power Administration has been signed by representatives of the federal authority and the Aluminum Company of America, the power to be used in additional aluminum production units at the company's Vancouver, Wash. plant, described on p. 630 of this issue. The Bonneville Power Administration had already signed contracts with the company to furnish 65,000 kw. of energy. When the Vancouver plant was first placed under construction, 32,500 kw. were contracted and this was doubled within a short period. The total power now under contract by the Aluminum Company is 162,500 kw.

In order to supply the power, Bonneville Administrator Paul J. Raver announced that two new generators at the dam, units 3 and 4, would be put into operation, giving the dam a total production of 194,400 kw. and that the first of Grand Coulee's large generators, to be in operation by early fall of 1941, would be utilized.

The Bonneville-Grand Coulee power administration now has power commitments totalling 204,650 kw. Present installed capacity of the grid is 86,400 kw.; ultimate capacity is 2,400,000 kw.

• • •

## George Washington school of engineering accredited

The Engineers' Council for Professional Development has announced that the school of engineering of the George Washington University was accredited at a meeting of that body Oct. 24. Frederick M. Feiker is dean of the college.

# Comment and Discussion

**Readers' opinions on matters that concern engineers and contractors**

## Scale Resistance on Lab

Sir: O. L. Moore's report on scaling of concrete pavement (*ENR*, Oct. 10, 1940, p. 471) was eagerly read and the reported results compared with those obtained by the writer in a similar investigation made at the Massachusetts Institute of Technology from February to June, 1939, under the direction of Prof. Roy W. Carlson.

Thirty specimens of concrete were subjected to some 60 cycles of freezing and thawing with their surfaces immersed in a concentrated solution of $CaCl_2$. Their size was 10x5x3 in., with a ½-in. mold around the top edge. Three different admixtures were used—Pozzolith, TDA and ABC—as well as a blend of portland and natural cement, and for comparison straight portland cement. Graded aggregate was used and the water-cement ratio was varied as needed to obtain a constant slump.

It was also decided to experiment with different types of finishes and to determine, if possible, the effect of surface finishing on scaling. A moderate, an excessive, and a compressive finish were tried: in the last-named process, a laboratory substitute for the patented process of producing vacuum concrete, the surface of the specimen was compressed and much of the excess mixing water was removed by the absorptive action of plaster of paris molds.

The conclusions, briefly, were that admixtures ABC and Pozzolith were very effective in producing increased durability and high resistance to scaling. The admixture called TDA, which, like ABC, is a grinding aid, failed to increase the resistance of concrete to scaling.

Specimens containing ABC and Pozzolith required less mixing water and contained a much higher percentage of air voids than those made with straight portland. This would indicate that frothing agents used to entrain air in concrete improve the resistance of the concrete to scaling and give greater workability.

From the standpoint of the effect of surface finishing, it was concluded that overworking of a surface is to be avoided if possible to prevent excessive bleeding. The compressive finish, which in effect removes excess surface water, produces a concrete surface which is much more resistant to scaling than either an excessive or a moderate finish.

Donald W. Scully
*Cambridge, Mass.*

## Scale Resistance in the Field

Sir: I would like to correct some erroneous conclusions deduced by O. L. Moore in his article "Pavement Scaling Successfully Checked" (*ENR*, Oct. 10, 1940, p. 471).

The general impression to which the reader is led after reading Mr. Moore's article is that the cause for improved resistance of the natural cement blend with portland over that of the straight portland cement concrete is the presence of a small amount of fat or grease in the natural cement. "It was found that the natural cement contained about 0.07 per cent of fat or grease (fatty acid materials), extracted by means of ether." The latter statement is generally true in the case of one of the natural cements (A) now extensively used by the N. Y. State Department of Public Works. During the construction of the 13 experimental concrete pavements built during 1935-36 another natural cement (B) was also used on some sections. The latter cement contained between 0.23 and 0.30 per cent tallow. On the basis of the 1:6 blend, with natural cement A the tallow or fat content would figure out about 0.01 per cent in the mixture, and with natural cement B between 0.03 and 0.04 per cent.

According to Mr. Moore's conclusions the amount of fat present in the natural cement blends was less than half enough to produce maximum scale resistance. If there was an insufficient amount of fat present in the natural cement A blend, the natural cement B blend containing between 0.03 and 0.04 per cent fat should have given better resistance to chloride action. As a matter of fact the reverse was true when the concrete cores were tested in the laboratory for chloride resistance. The concrete with natural cement B blend showed very little or no improvement over the straight portland cement concrete, whereas the natural cement A blend was good. The table below illustrates the laboratory results on three different experimental highway projects in which both natural cements with the same portland were used in the proportions of 1:6 or 2:5 blends.

**Freezing-and-thawing tests of pavement cores**

| H'way | Natural | Portland | Blend | Chloride freez. and thaw. tests. Av. weighted loss of 3 cores. | |
|---|---|---|---|---|---|
| | | | | 25 cycles | 50 cycles |
| 1 | .. | H | ... | 24.8% | 100.0% |
| | B | H | 2:5 | 11.5 | 83.8 |
| | A | H | 2:5 | 1.0 | 4.1 |
| 2 | .. | D | ... | 52.9 | 100.0 |
| | B | D | 1:6 | 29.1 | 50.9 |
| | A | D | 1:6 | 0.4 | 3.0 |
| | B | D | 2:5 | 21.6 | 42.6 |
| | A | D | 2:5 | 1.2 | 4.9 |
| 3 | .. | W | ... | 25.7 | 46.1 |
| | B | W | 2:5 | 27.6 | 54.7 |
| | A | W | 2:5 | 0.3 | 4.2 |

In another project some natural cement A blend free of tallow was used. Chloride freezing and thawing tests on cores from that pavement showed a loss of 52.3 per cent by weight with the straight portland, and a loss of only 1.0 per cent with 1:6 blend, at the end of 50 cycles.

Several projects have been built recently in New York State with tallow and vinsol resin treated portland cements, and natural cement blend with untreated portlands. The laboratory chloride freezing and thawing tests on cores taken from the pavements have shown little difference in resistance between the treated portland and natural cement blends.

Ira Paul
*Director Public Works Laboratory*
*New York State Department of*
*Public Works, Albany*

## Column Fails Underground

Sir: The accompanying photograph shows a reinforced concrete column that failed below the ground floor slab during the earthquake in the Imperial Valley, May 18, 1940. Whereas such failures are common enough in columns above ground, this is the only instance that I know of where such a

Earthquake causes unusual failure

failure occurred below. The column was 14x14 in. reinforced with four ¾-in.-square twisted bars, and carried a dead load of some 80,000 lb. This overload was caused by the addition of a second story to the original one-story building. However, all the adjacent surrounding columns did not suffer any damage.

Edward L. Mayberry
*Architect and Engineer*
*Brawley, Calif.*

## Welding Restrictions

Sir: I have read with a great deal of interest Mr. Chaffee's letter (*ENR*, Aug. 15, 1940, p. 207), but it seems to me that he has entirely missed the point.

It is generally recognized that only a comparatively small amount of welding is being done which can and should be done. Why doesn't this tremendous amount of welding with its thousands of jobs for welders develop more rapidly? Well, partly because of tradition and largely because the progress of welding is being held back by every kind of law, code, rule, restriction, etc. made and passed by societies, city councils, state legislatures, federal authorities and any one else that cares to. The unfortunate part about this is: (a) Many rules, codes, etc. are unduly restrictive, and what is permitted in one code is restricted or forbidden in another and vice versa; and (b) The cost of welding, due to test and unnecessary restrictions, is in many cases increased to the point where it is uneconomical and cannot compete with other methods.

Why do we have this more or less chaotic condition? Because the public has been led to believe that welding is something mysterious, that requires that the Good Lord must come down and personally supervise each welder and his work.

Such is farthest from the truth. Everyone who knows welding knows that a good welder, (note, I say "good welder"), furnished with proper material and equipment, will consistently make welds that are stronger than the material being welded.

Is the trained riveter beset by checkers and inspectors on every rivet he drives? Is the trained machinist harassed by supervisors on every operation of his lathe? Do we X-ray every casting that is used? We do not mean by this that really necessary precautions for safe, reliable welding should be eliminated. The point is that the welder is not being given a break. We are not in any way trying to cast a reflection on him as has been implied. What we are trying to do is to get the same acceptance for the work from a good welder that is given to a riveter, a machinist and other recognized professions or trades. When that is done, the scope of welding will broaden tremendously and the call for welders will be far greater than the supply.

A. F. Davis
*Vice President*
*The Lincoln Electric Co.*

## Professional Work

Sir: The editorial entitled "Professional Work Defined" in the Oct. 24 issue of *Engineering News-Record* confirms the opinion which many engineers hold that the editorial policy of your magazine represents not the interest of the engineering profession but the interest of the manufacturers who advertise in your magazine.

We resent the entirely false assumption which you make of speaking for our profession. If "Not one of the organizations that profess to be working for the advancement of engineering as a profession was represented at the hearings on the subject" perhaps it was because those organizations did not feel that it was to their advantage to do so.

I have no doubt that the "ball was carried by the manufacturers." Unless they can secure low paid engineering employees they will be unable to furnish the "free" engineering service so widely advertised.

It seems obvious that the profession is rapidly becoming submerged in industrial, commercial, and political organizations. Unless something drastic is done to save it it will soon cease to exist as a distinct profession.

Milton H. Blez
*Registered Professional Engineer*
*Philadelphia, Pa.*

Broadening the scope of the professional classification under the Wage-Hour Act, which is the effect of the new definition of "employees employed in a bona fide professional capacity," appears to us to be an important factor in keeping the profession from "becoming submerged in industrial, commercial and political organizations." Unfortunately, however, this question of broadening the scope of the professional classification cannot be divorced from the union question because the unions urged that the definition be so narrowly drawn as to exclude practically all salaried employees. Thus the issue cannot be discussed as abstractly as it should be discussed for the benefit of all concerned.—Editors

## Engineers as a Profession

Sir: The ruling by Col. Philip B. Fleming, Administrator of the Wage-Hour Division of the Department of Labor, as reported in the *ENR*, Oct. 17, p. 504, relating to "professional" provides "that subsection (B) shall not apply in the case of an employee who is the holder of a valid license or certificate permitting the practice of law or medicine. . . ." Apparently a licensed engineer is not in the same professional class as a lawyer or a doctor in the opinion of Col. Fleming. He ruled, undoubtedly, on the basis of the hearings held by the Department of Labor, and if so our national engineering societies failed to present a case which assured the recognition of the professional status due the licensed engineers.

This matter is necessarily one of many ramifications but the increasing misguided pressure of labor groups to control all earning capacities of the country makes it imperative to obtain full recognition of the professional status of engineering to distinguish it from the related non-professional skills.

Miles N. Clair
*West Newton, Mass.*

# EDITORIALS

VOLUME 125 NUMBER 19

*November 7, 1940*

## "You're in the Army Now"

POLITICAL NEWS dropped to second place in the minds of millions of young men in every walk of life last week as numbers were drawn in the draft for military service. Doubtless there will be many engineers among those selected to whom the prospect is discouraging; it looks like a year lost out of time that should be devoted to developing skill in their chosen profession. But if we can judge by the experience of many engineers who left peacetime occupations to serve their country in the first World War, the time will not be wasted. The army is a great school in human engineering. There you do not pick your companions; you have them assigned to you. You have to learn to live with them and work with them. That is a valuable experience. And to any man who shows initiative, an opportunity is given to act as a non-commissioned officer. Corporals and sergeants learn how to handle men under harsh conditions that permit no compromise. Ability to handle men is a priceless asset to any engineer. Improved physique is another factor to be entered upon the asset side. Army life is hard and at times monotonous, but few who have seen military service charge off the time so spent as lost.

## Making Tunneling History

TUNNELING SKILL OF TOP RANK is displayed in the fast hard-rock work at Carlton and in the Maas trench-tunnel construction at Rotterdam. Both jobs, subjects of articles in this issue, write new tunnel history in their separate departments of the art. In one sense Carlton is the more noteworthy because its new records of speed are due primarily to excellence of organization of working forces and operations—plus the factor of drive that is the real key to every big performance. The significance of the Rotterdam tunnel, on the other hand, is in part due to the ingenious methods and details developed by the engineers and contractors. The jacking system for positioning the huge individual tunnel sections—by far the largest yet built—represents the most carefully developed method yet used for the purpose; it assures a precision of placing the sections such that, if full success is attained in bedding them on permanent solid bearing by the sand flushing method, a mechanically perfect structure will result. The combination of diving bell and compressed-air procedure for making the joints between the sections is further testimony to the care and ingenuity exercised by the engineers and contractors in planning the construction procedure. In more than one way the work marks a definite forward step in the trench tunnel field.

## How Much Sewage Treatment?

NOT OFTEN does a newly formed technical society find a job for the public good waiting and ready for it to tackle. But at the first annual convention of the Federation of Sewage Works Associations such a job was suggested by Prof. Abel Wolman of Johns Hopkins University when he made a plea for a sane and realistic attitude toward stream cleanliness standards. He was not advocating "dirty streams" as so many believed, but he properly questioned the economic validity of standards for waste discharges which would make every waterway glisten with pristine purity. It is no trick today to process domestic sewage so that the end product is an effluent more sparkling than spring water—provided you are willing to pay what it costs—but, obviously, there is no justification for such high degree of treatment in most communities. How shall standards be determined, therefore, which establish an economic balance between stream requirements and sewage treatment? Here is the job for the Federation. It offers an opportunity to perform a great public service.

## Road Salvage with Mud Jacks

SALVAGING OPERATIONS being conducted in Illinois on 25 miles of relatively new concrete pavement warrant the attention of all highway engineers. Water working down through joints and cracks was trapped in an impervious clay subgrade and the subsequent pumping under heavy truck traffic created voids under the pavement. Progressive cracking and settlement indicated an early breakup of the pavement unless the pumping could be stopped, and the work described in this issue has that objective. Mud jacks are being used to pump a special type of slurry under the pavement to fill all voids and seal the cracks and joints. Where settlement has occurred, the pavement is jacked back to proper level. The slurry is a mixture of cement, lime dust, loam, road oil, clay and water, the result of intensive studies made last winter. Worthy of special note are the nozzles used, each being so designed that either compressed air or slurry can be forced into holes through the pavement, compressed air being used to blow out entrapped water and keep the slurry moving. The job is a fine example of how familiar methods and available equipment can be modified to meet a new problem.

## Important Airport Decision

SIGNIFICANT to our national defense effort is the decision of the Civil Aeronautics Authority to carry out its $40,000,000 civil airports improvement program by contract construction under supervision of a Corps of Engineers officer. Airport construction for the past few years has been the particular province of the WPA and in fact did offer an ideal type of work for relief labor when the provision of jobs was the only criterion; hundreds of men could be employed for many months in grading a 300 or 400-acre site with hand shovels and in leisurely building of drainage lines and hangars. But giving jobs is not the only criterion now. We need usable airports in a hurry and we need the maximum of facilities for the money available. On neither count does a relief labor program measure up. Hand shovels must give way to 12-yd. tractor-drawn scraper wagons and leisurely schedules must be replaced by high pressure attack. Contractor organizations can supply these necessities and Army Engineer supervision can guide the work effectively. In the end a large number of jobs will also be provided. It was a wise decision.

## Blackout Factories

PROPONENTS OF WINDOWLESS FACTORIES have been given a new argument favorable to their cause by the War Department's expressed interest in "blackout" provisions. They have, in fact, had an unfavorable argument countered, because the dark tomblike aspect of a windowless plant at night is generally disliked. The blackout factor, if seriously applied to our industrial plants, could, indeed, introduce significant changes in design. Probably blackout can only be considered of vital importance for key defense plants, but there are enough of these existing or proposed to focus attention on the windowless plant.

The windowless plant is automatically blacked out. Several have been built since the Simonds Saw & Steel Co. pioneered in this type of structure but only in recent ones, such as the Allison airplane engine plant and the Grumman and North American plane plants, was any consideration given to invisibility from the air. Even in these plants, as in all of the others, the ability to control light and air as an aid to production has been the deciding factor in favor of windowless construction. This was the case with the Buda Co. plant described in this issue and there, as elsewhere, the decision was made easier by the development of fluorescent tube lighting whose lack of heat generation permits great reduction in air-conditioning capacity.

The windowless plant can be considered a success mechanically, but it still requires much study to make it a success architecturally. Most common and acceptable expedient has been to utilize panels of glass block to relieve the monotony of masonry walls, but a blackout requirement would require some changes in these details, perhaps the use of opaque paint or shutters on the inside.

When existing plants are viewed from a blackout standpoint, paint and/or shutters assume a dominant role, unless complete reconstruction is considered. The West Coast aircraft plants are particularly apt illustrations of existing facilities that might require a major overhaul because of blackout. Their acres of sawtooth roof sash and sidewall glass are as effective as spotlights in revealing their location from the air. If interior light is to be confined, however, exterior air is usually excluded, and a problem of artificial ventilation is introduced. Blackout remodeling, therefore, would convert these factories into true windowless buildings.

However, the blackout factor, potent though it may be for certain plants and in emergency times such as these, will not make the windowless plant a dominant type. Only the controlled conditions of light, air, humidity and temperature that the windowless plant offers can do that. And these are the economic and owner-preference factors that have always determined industrial building development.

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**ENGINEERING NEWS-RECORD**

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F. E. SCHMITT *and* WALDO G. BOWMAN, *Editors;* VAN TUYL BOUGHTON, *Managing Editor; New York:* EDWARD J. CLEARY, ARCHIE N. CARTER, H. W. HUNT; *Chicago:* W. W. DeBERARD, HAROLD W. RICHARDSON; *San Francisco:* N. A. BOWERS.
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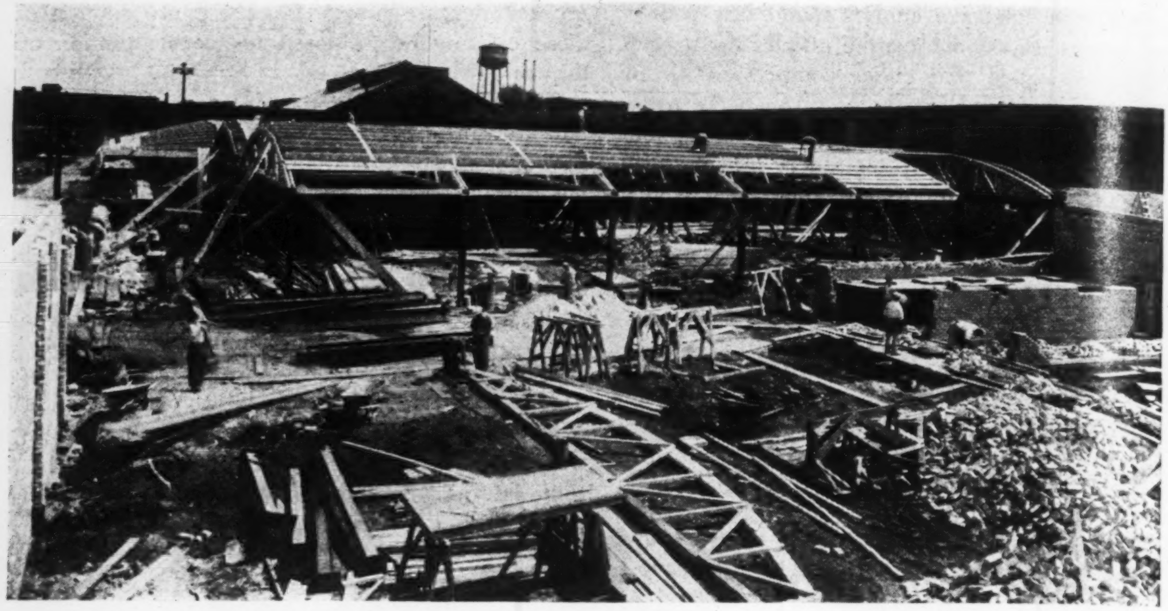


Fig. 1. Wood roof trusses were fabricated on the ground, lifted into place complete.

# Windowless Plant for Diesel Engines

**Contents in Brief**—*Six weeks from the time the contract was let, the Buda Company, Harvey, Ill., moved into its new factory building designed for manufacture of radial-type diesel engines, many of which will be used on army equipment. It is of low-cost construction, yet highly efficient, incorporating the latest modern ideas in windowless design, pressure dust-proof ventilation and fluorescent lighting. The structural design is brick walls, steel columns and wood truss roof.*

WHEN THE BUDA COMPANY, of Harvey, Ill., received a large order for its new radial air-cooled diesel engines from the U. S. Army, additional factory space was needed in a hurry. Several contractors were asked to submit bids on buildings of their own design that met a few general requirements of the company. The type and layout of the building and many of the details were left to the contractor.

Continental Construction Co., Chicago, was awarded the contract on July 31, and moved onto the job the next day. General plans were completed in one day, and details were worked out as the job progressed. On Sept. 16, six weeks after breaking ground and 12 days ahead of the contract time limit, the Buda Co. started to move in equipment.

In twenty years of industrial building experience, the contractors had made many studies of design and construction features of industrial plants to meet various requirements and conditions. These studies led them to consider the following factors in approaching a client's needs with an open mind: lowest investment in keeping with requirements, plant charges on products to be produced in the new building, and esthetic treatment (if necessary); time allowed for construction; availability of various materials which would be required on short notice; and the labor situation in regard to trades available for various types of construction. With results of previous studies at hand, conferences between the contractor and officials of the Buda Co. resulted in a quick choice of the type of building to be erected.

An irregular tract of land, roughly 164 x 200 ft., adjoining a small building erected last spring for start of the engine production, was available. This tract provided room for 36,000 sq. ft. of floor space in a one-story building, ample to meet the requirements. The fast construction schedule and conditions of the local material and labor markets led to a design of brick walls and wooden truss and roof construction carried on steel columns, including wall columns that permitted work on the roof to proceed simultaneously with wall construction.

Because of the precision required in the engine manufacture, dust control was essential. This led to adoption of pressure ventilation that would keep outside dust from entering the building. An internal air pressure of 1 oz. per sq. in. higher than atmospheric is considered sufficient. While air conditioning is not required in the manufacturing process, surges or rapid changes in temperature are undesirable; modified air conditioning, therefore, was incorporated in the ventilation system. Insulation in the roof was also adopted as a measure of temperature control.

Pressure ventilation suggested a minimum of openings to reduce air losses, which led to a design without windows or skylights, and with the doors (as few in number as possible) sealed against loss of air. This, in turn, required full artificial illumination, met by an installation of daylight-type shadowless fluorescent lighting, highly desirable because of the precision of work to be done.

The wood roof trusses are of 50-ft. span, placed 18 ft. apart in longitudinal direction to reduce the number of columns in the building and to provide a series of wide transverse bays suitable for departmental operations. The manufacturing process requires the use of large lathes and other heavy machine tools, but it was desirable to make the arrangement of manufacturing operations as flexible as possible. Therefore, instead of trying to spot and build separate foundations for each machine in advance, a heavy-duty floor of 8-in. reinforced concrete, designed for a loading of 2,500 lb. per sq. ft., was built over the entire floor area. The machine tools can be placed anywhere on the floor, and, furthermore, the building will be suitable for other manufacturing processes when the defense emergency is over.

### Design details

Foundations are simple, consisting of concrete spread footings, 4 ft. deep, with concrete walls extending 6 in. above the floor line. The building walls are of solid brick, left exposed on the inside, and topped by a tile coping. Steel columns are 8-in. H sections; those in the interior rest on small concrete mats.

The roof trusses clear the floor by 12 ft. They are of the bowstring type. The top chord is made up of twelve 2 x 3-in. strips, nailed and bolted to a curve with a rise of 7 ft. Bottom chord ties are two pieces of 3 x 8-in. timbers. Web bracing members are 3 x 4-in. timber.

Bottom chords of adjacent trusses are tied together at midpoint and at tops of columns by 2 x 6-in. and 2 x 8-in. planks. Every third pair of trusses is braced by 2 x 8-in. diagonals. Roof joists are 2 x 12-in. planks on 24-in. centers, carried directly on the top chords. Roof covering is planking nailed across the joists, insulation and a 10-year asphalt roof.

Doors are 8-ft. opening, of the overhead folding type, sealed with rubber strips to prevent loss of air. Outside of one door is a receiving platform within a brick inclosure, which is fitted with two tight doors. The two sets of doors will act as an air lock to hold the inside pressure;

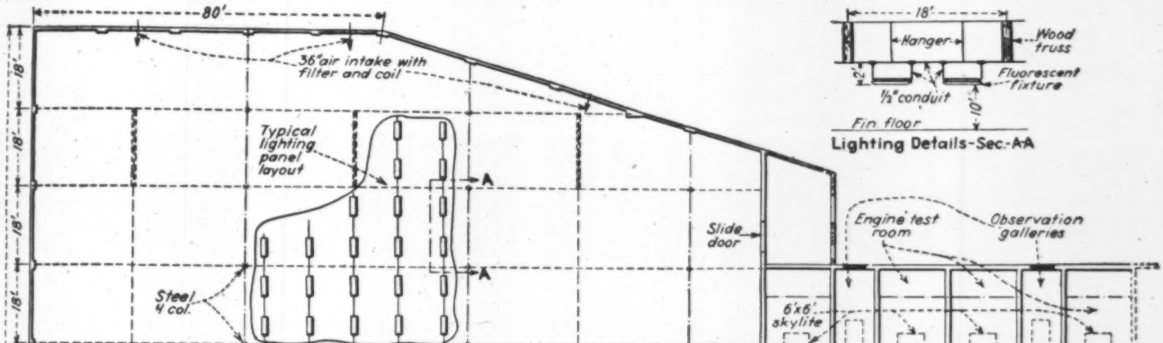

80'
18'
164'
14'
36" air intake with filter and coil
Typical lighting panel layout
A
A
Steel 4 col.
48" exhaust fan
2"x12"x24" o.c. roof joints
2"x6" and 2"x8" Ties
Roof trusses
8" conc. floor reinf. 6"x6"-No. 6 mesh
2-2"x8" "X" braces
Sealed overhead door
Balcony
36" φ air intake with filter and coil
36" air intake with filter and coil
Receiving room lock
Platform
8'
50'
250'
First Story Plan
Slide door
Brick partitions
Toilet and locker room balcony
Engine test room
Observation galleries
6'x6' skylite
4'x12' skylite
48" exhaust fan
Party wall removed
18'
Hanger
Wood truss
Fluorescent fixture
½" conduit
2'
10'
Fin. floor
Lighting Details-Sec-A-A
Top chord-12-2x3's
Webs-3x4"
Steel cols.
12'
Bott. chord-2-3x8's
Fin. floor line
50'
Longitudinal Section

**Fig. 2. Layout of the new plant. Note the wide bays, lighting arrangement and locations of pressure ventilation fans.**

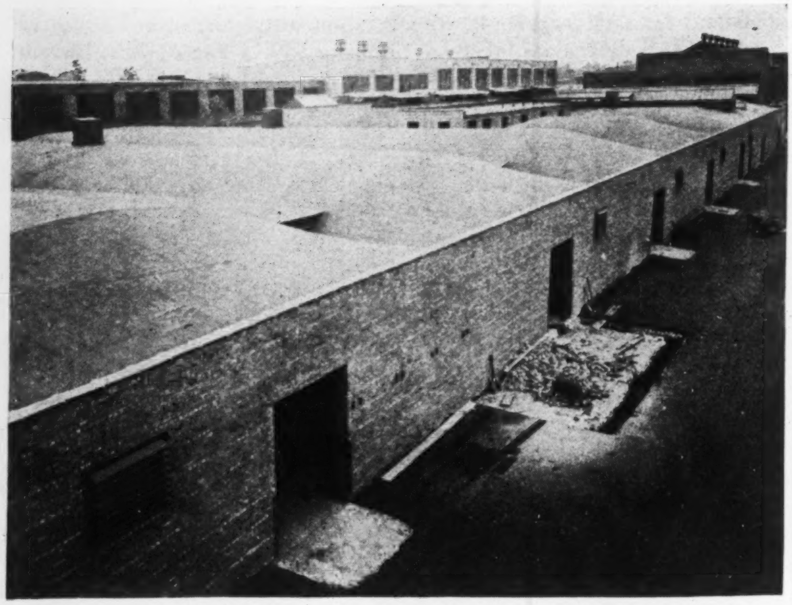


*Fig. 3. The completed new plant, windowless, pressure air-conditioned and fluorescent lighted. Foundation work for door "airlock" in center foreground.*

only one set will be opened at a time. The partition between the new building and the smaller structure completed last spring will be knocked out. Skylights, windows and doors in the smaller building will be sealed, so the whole factory will operate under the pressure ventilation system. A shipping lock similar to the receiving lock is located in the older building.

In one corner of the new factory are four specially constructed soundproof dynamometer engine rooms arranged in pairs with an observation gallery and test laboratory between them. These test rooms are insulated by brick partitions from the general factory area and have skylights for ventilation. An interesting feature of the test stalls is a pair of curved baffles, built into the doors, that will deflect the air stream from the engine fan upward to ventilating louvres, thus preventing building up of back pressure and turbulences of air caused by the fan. The baffles are made of thin plywood fastened to curved angle irons. Each test room will contain a 1,100-hp. dynamometer for testing the engines, mounted on special concrete foundations.

Pressure ventilation will be provided by eight fans, fastened to the interior of the outside wall. From 36-in. round intakes in the walls, the incoming air will pass through glass filters and around coils that will be heated in winter and cooled in summer. A new well is being drilled to supply the cooling water. Air will be exhausted from the building through four 48-in. fans installed in the crown of three roof bays and discharging through ventilation louvres. Heat from waste steam will be supplied through unit heaters and steam pipes hanging from the trusses.

The lighting is most modern, consisting of five rows of fluorescent fixtures hanging from the trusses in each transverse bay. Each 18 x 50-ft. area within a set of columns has eight such fixtures. They hang 2 ft. below the trusses, 10 ft. from the floor. At floor level the light is rated at 25 foot-candles; at bench level it is 32 foot-candles.

To save valuable floor space, all toilet, washing and locker facilities are concentrated in a balcony near the test rooms.

#### Fast construction

The fast construction schedule of six 5-day weeks was maintained through careful advance planning that not only eliminated all interference between trades, but coordinated their activities. First operations were clearing the site of several storage tanks. A shovel dug the foundation trenches, and as soon as a section of concrete footings was ready, column and truss erection was started.

The trusses were fabricated on the job, and were lifted into place complete by a truck crane. As soon as a set of trusses was up, roof construction started, and the electricians, steamfitters and sprinkler pipers begun hanging their services from the trusses. In the meantime the walls were started. Bricklayers worked elbow to elbow. Just as soon as the sewers were out of the way laying of the floor started. It was placed in three days by a regular highway paving outfit. Liquid hardener was added to the floor to prevent dusting.

Theodore A. Thompson of the Continental Construction Co., Chicago, supervised the design and construction.

## Indirect Accident Cost

Data on construction accidents which show that indirect expenses often greatly exceed the direct costs were given by E. R. Granniss, of the National Conservation Bureau, Association of Casualty & Surety Executives, New York, in a recent address before Army engineers. In one case, an electrician working on an overhead junction box lost his footing, and the falling scaffold struck an instrument panel; direct expenses for attendance on a broken leg and compensation were $305, but damage to the instrument board cost $730 and extra help with miscellaneous costs amounted to $210, a total of indirect costs of $940 added to the direct cost of $305 which alone was entered in the employer's accident record. In a second instance a truck driver who ran through a stop sign and collided with another vehicle was responsible for a direct cost of only $2.50 for medical attention to his bruises, whereas the driver's lost time, cost of truck repairs and loss of truck time, etc., amounted to $54.75, or more than twenty times the cost charged against the accident in the record.

Mr. Granniss computed that of the total construction in 1939, taken from *Engineering News-Record* figures as $6,974,000,000, the annual payroll (at 40 per cent) was $2,789,600,000, for which about $250,000,000 was spent in insurance premiums. With an average loss ratio (covering only direct costs) of $150,000,000 (estimated at 60 per cent of the premiums paid) an indirect cost of six times this amount may be assumed, according to the ratio accepted by the Associated General Contractors, or a 1939 loss of $1,000,000,000.

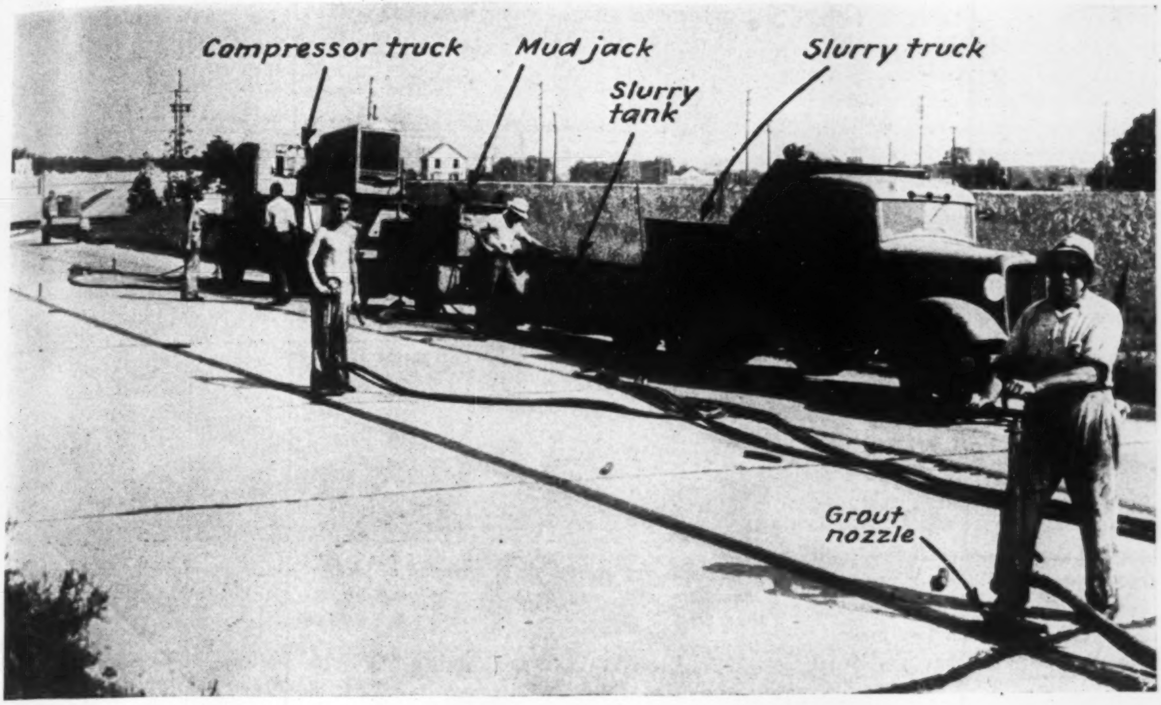


**Fig. 1. Mud jack crew sealing and raising concrete pavement in Illinois.**

# Illinois Jacks Up Paving

**Contents in Brief**—*To save a 4-year-old concrete superhighway from disintegration over a pumping subgrade, Illinois is jacking up 25 miles of four-lane pavement by forcing a slurry of oil, cement, lime dust, loam and water through holes drilled in every slab section. The procedure, costing 4c. per sq. yd., forces trapped water out of the subgrade, lifts sunken slabs and seals open joints. Combination nozzles take the slurry from a mud jack and compressed air from a compressor. Costs for the work are low.*

WATER trapped in the heavy clay subgrade is causing the concrete slab sections on the paving on U. S. Route 41 through Lake County, Ill., between Chicago and Milwaukee to pump at the joints and cracks. Although the pavement on the four-lane divided superhighway is only four years old, much of it is already badly cracked and has settled under the heavy truck traffic. In an effort to save the pavement and to restore the road to first-class condition the Illinois Division of Highways is carrying out a systematic program of forcing the water out with compressed air and filling the subgrade voids and lifting the slabs back to position with a cement-oil-earth slurry forced through drill holes by a mud jack. The procedure, based on experiments conducted last fall, is proving highly satisfactory, and promises to postpone more extensive rebuilding of the road for at least two more years. All work is being done under traffic.

The Lake County section of Route 41, which is known as Skokie Highway, consists of two divided lanes of 20-ft. pavement. Each lane is made up of two 10-ft. strips, with doweled center joints and with transverse joints, also doweled, every 30 ft. Pavement thickness is 10–8–10 in. On bridge and underpass approaches each lane widens out into three 10-ft. strips, and the pavement rests on a gravel cushion. Elsewhere the slab was placed directly on impervious Illinois clay. Wide clay shoulders and flat terrain prevent adequate drainage of the tight subgrade.

Although the mud-jacking program is being carried out consistently over the entire length of pavement, little is being accomplished in the gravel subgrade areas except sealing of the joints since the paving, for the most part, is in excellent condition.

### Central mixing plant

The slurry is mixed at a central mixing plant. All materials, including oil, are trucked into the plant, and the mixed product is hauled out to the job in two tight-body dump trucks fitted with a pipe discharge. The slurry mix is made up of the following percentages of materials, proportioned by volume:

| | |
|---|---|
| Portland cement | 8 |
| Lime dust | 6 |
| SC2 road oil | 13 |
| Black loam | 25.5 |
| Clay | 6.5 |
| Water | 41. |

The proportions are the result of much experimenting. The oil keeps the slurry plastic on long hauls to the job, retards the setting and prevents

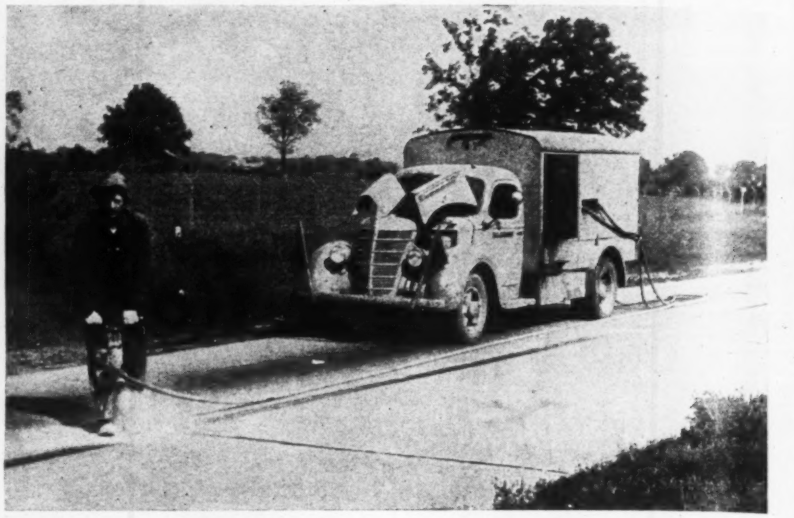


*Fig. 2. Holes are drilled far in advance of jacking procedure by a truck-mounted compressor with long hose lines serving hand operated drills equipped with 1¼-in. bits.*

trapped water under the slab from combining with or diluting the slurry.

The clay and loam are mixed, with part of the water, in a 7S concrete mixer that has been closed tight with steel plates to prevent the materials from slopping out. Discharge from the mixer is through a pipe and through a ¼-in. mesh screen into a slurry box. Here the mix is kept agitated by recirculating through a 2-in. centrifugal pump. From the slurry tank the mix is discharged through another screen into a bituminous mixer, 6 cu. ft. to a batch. One bag of cement, one bag of lime and enough more water to total 13 gal. per batch are added to the mixture in the second mixer, along with the oil.

Two of the clay-loam batches, with cement, dust and oil added, make up one 12½-cu. ft. batch in the second mixer. Three such batches make a truckload. The oil is supplied from 850-gal. trailer tanks, through a 300-gal. distributor and heater, and into the mix through a job-made calibrator. It is heated for a couple of hours in the morning, which keeps it warm enough to handle properly all day.

### Drilling and Jacking

Operating well in advance of the jacking is the drilling crew, equipped with a portable air compressor, mounted on a truck and two hand-held rock drills fitted with 1¼-in. drill bits and long pieces of air hose. For water expulsion, filling voids under the slab and sealing the joints, a hole is drilled near each intersection of four slabs, 10 in. from the center longitudinal joint and 10 in. from the transverse joint. Holes are also drilled close to intermediate cracks in the pavement. Where a slab is to be lifted back to original level, an additional hole is drilled near the outside edge of the pavement, 30 in. each way from the intersection of the transverse joint with the outside edge of pavement. Location of the holes is shown in Fig. 3. Practically all lifting is in the outside lane, which carries the bulk of the heavy traffic; the inside, or passing lane, seldom shows settlement. Occasionally a drill will strike a dowel, in which case a new hole is drilled alongside.

In treating the pavement, compressed air is used to force the trapped water from under the slab and to aid the mud jack to push the slurry into every void. Where no lifting is to be done, each transverse joint is vented at the outside edge of the pavement by digging away the shoulder material, but for areas to be lifted the water is forced out of the joints and through untreated holes.

Jacking equipment includes a portable air compressor on a truck, a double-cylinder trailer model mud jack, powered by a gas engine, and a slurry storage tank on wheels, the last two units being pulled along in tandem behind the truck, and four special grout nozzles. Each nozzle is connected with two rubber hose lines, a 1¾-in. line for slurry from the mud jack and a ⅜-in. air hose from the compressor. Air pressure is carried at 92 lb.; mud pressure is about 60 lb. per sq. in. One set of hose is 150 ft. long, two are 75 ft. and one is 50 ft., permitting working 150 ft. ahead and behind the equipment, or a total coverage of 300 ft. of pavement from each stop

The trucks hauling from the central plant dump the slurry into the storage tank. One of the two pumps on the mud jack, converted into a suction pump, draws the slurry from the storage tank into the mud jack, where it

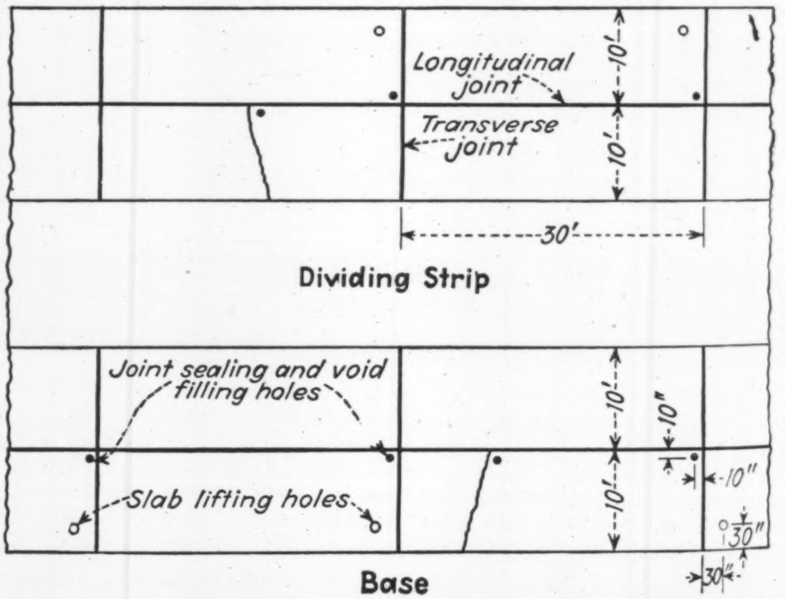


*Fig. 3. Typical location of sealing and lifting holes in relation to pavement joints.*

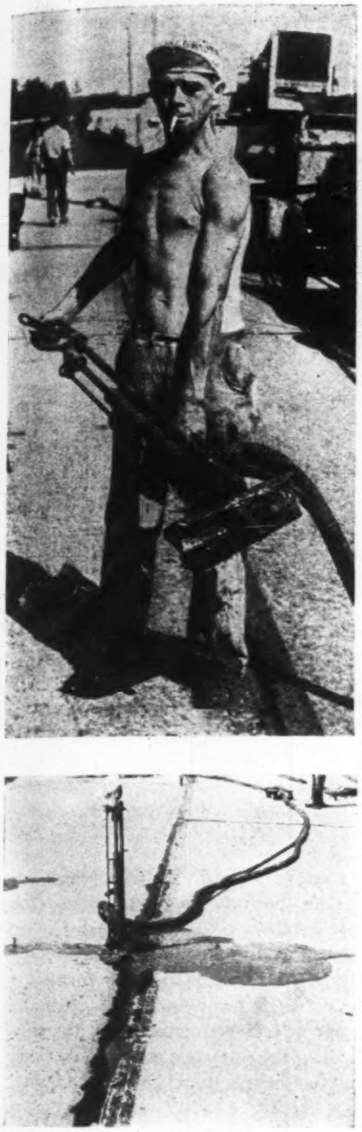


Fig. 4. Grout nozzles have a tapered snout that fits snugly into drill holes. Note the separate air and slurry hose lines. The slurry boils up through the joints, effectively sealing them. Excess grout is removed from the slab with a shovel.

is agitated and then forced to the grout nozzles by the second pump.

The nozzles were designed especially for this job (Fig. 4). A tapered snout fits into the hole in the slab; above the snout is a foot bracket upon which the operator can stand to keep the nozzle from blowing out of the hole. Air and slurry intakes are controlled by separate valves.

As most of the work is done in the outside lanes, traffic is diverted to the inside lanes. The procedure is to treat about 5 miles of north-bound lanes, then double back on the opposite side. The rigs are moved ahead in 300-ft. jumps, and at each stop the four nozzles are assigned to definite groups of holes within reach of the various lengths of hose.

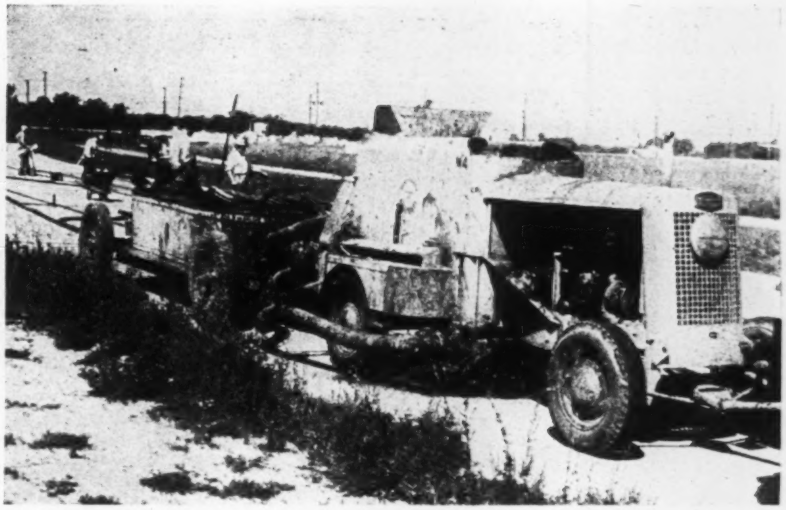


Fig. 5. One of the two pumps on the mud jack (near side) has been converted from pressure to suction operation for pumping the slurry from the portable tank to the jack. This equipment pumps an average of 23 cu. yd. of slurry per day.

### Method of operating

When a nozzle is first inserted into a hole, air is applied to blow out as much of the water as possible, which escapes through the joints, through the vent holes at the ends of the transverse joints and through untreated holes. Then the slurry is applied, without air, to fill the voids. Shots of air are admitted between shots of slurry to force the mix the maximum possible distance, but air and slurry are never admitted together. Where there is evidence of considerable water under the slab, it is sometimes necessary to strip short sections of the mastic filler from the joints to allow free escape of the water.

When a slab is not to be lifted, grouting stops when the slurry appears at top of joints or starts flowing from adjacent untreated holes. Then wood plugs are tamped into the treated holes to help hold the pressure. In lifting slabs the ends of the joints are not vented, the plugs in surrounding holes are pounded tight and clay is tamped into leaky joints. The usual lift is less than 1 in.

After all the holes in a set-up have been treated, the equipment is moved ahead, the wood plugs pulled and the holes sealed with clay. Later the holes will be cleaned out and sealed with a mastic filler by the maintenance patrol. The slurry sets in about 3 hr. During this time traffic is allowed to use the treated lanes, since experience has shown that it has little effect in disturbing the slurry.

### Costs and quantities

The entire crew consists of 20 laborers, two flagmen and a foreman. Three men are assigned to the drills, two are driving trucks, six work at the central plant and 11 are on the jacking procedure. An average day's run of 9 hr., of which 7 hr, represents actual working time, is 3,200 lin. ft. of 20-ft. pavement. A total of 23 cu. yd. of slurry is pumped, about 6 cu. ft. per 30-ft. joint. In the average day 25 sq. yd. of slab is lifted $\frac{3}{8}$ in. The average cost is 4c. per sq. yd. treated, including all labor, materials and plant charges, or $10 per cu. yd. of slurry pumped.

### Direction

The work is being carried out by state highway maintenance forces under the direction of C. H. Apple, district engineer and Joseph Miller, maintenance field engineer, of the Elgin district office. Tony Kunzer, special maintenance engineer, is in charge in the field. John Poulter of the Koehring Co. assisted in developing the slurry mix, the grout nozzles and the procedure of application.

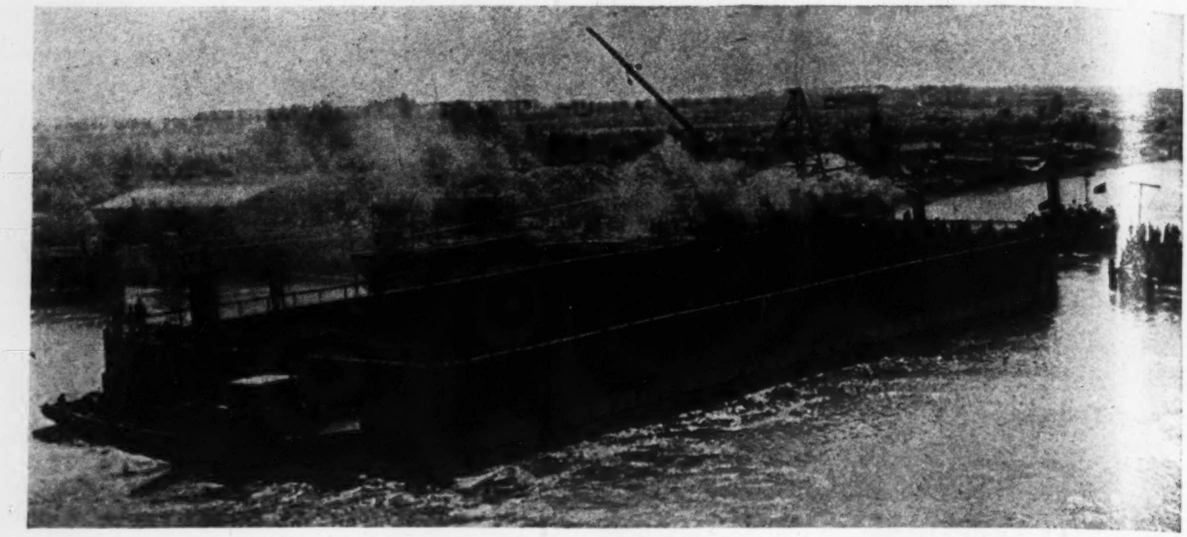


**Fig. 1. Half-finished caisson for Rotterdam tunnel being towed from drydock for completion afloat.**

# Precision Devices for Sinking Tunnel Caissons

**J. P. Van Bruggen**

Engineer in Charge, Municipal Technical Service, Rotterdam, Holland

***Contents in Brief***—*Written before the invasion of Holland, this article describes construction of the great vehicular tunnel under the River Maas at Rotterdam. Although the work is now no doubt abandoned for the duration of the war, the construction procedure that had been developed is well worth recording. Precast concrete boxes 81 x 27½ x 202 ft. were to be sunk to rest on sills of concrete previously placed on the river bottom. Leveling and alignment of each section was accomplished by hydraulic jacks installed in the box walls. Special air-lock and diving-bell equipment enabled ends of boxes to be connected under compressed air. Sand was pumped under caissons to insure even bearing.*

UNUSUALLY EXACT METHODS were developed for aligning, leveling and coupling the shore-built units for the under water part of the River Maas tunnel at Rotterdam, Holland. A rectangular section was adopted for the tunnel, and for the under-river part of about 1,900 ft. it was decided to sink end-to-end nine prefabricated concrete caissons and connect them under water. These boxes are 202 ft. long, 81 ft. wide and range from 26 to 31 ft. high. Each weighs about 14,500 tons. Three vertical and one horizontal partitions divide the caisson (Fig. 2) into two roadway tubes, a tube for pedestrians and a tube for bicycles. Therefore the sinking of the caissons is required to be so accurate in level and profile that the box-walls and partitions will meet end-to-end to form smooth continuous tubes from shore to shore. The means for accomplishing this consisted of concrete sills placed on the river bottom and of jacks on the caisson that take bearing on the sill to correct line and level after the caisson is sunk.

### Casting and sinking

The construction of the caissons is started in drydock. Here three at a time the floors are laid and the sidewalls are built up halfway. To make it watertight each caisson has a shell of $\frac{5}{16}$-in. welded plates enclosing bottom, top and sides. The bottom and sides of the shells are set up in the drydock as shown by Fig. 3 to serve as outside forms for the concrete floor and walls. With the drydock concreting finished, the ends of the caissons are closed by wood bulkheads and the caissons are towed, Fig. 1, to a jetty and completed afloat.

The finishing of the caisson is notable for the devices installed for sinking, leveling and coupling. As the caissons when completed weigh more than the water displaced by submergence, air tanks are attached to each side. Concrete bulkheads replace the temporary wood bulkheads before sinking begins.

The plan is to sink the caissons in succession from one shore to the other so that in the first caisson to be sunk an air lock is installed in the outshore bulkhead as indicated by Fig. 4. This is transferred from one caisson to another, as described later. A portal-shaped tower of steel is erected on each end of the caisson by which to check its alignment in sinking and for other work of leveling and coupling. Sliding spuds operating in four vertical wells, and hydraulic jacks near the bottom on each side of the caisson are installed at about each quarter point. Precast concrete cross-sills, with curbed ends, are placed in the dredged trench to receive the spuds and jacks. These devices are shown in Fig. 5.

The caisson to be sunk is towed to position, and a floating crane takes hold at each corner. Water is admitted to the flotation cylinders and the cranes lower the caisson onto the bearing sills keeping line and level by observations on the alignment towers.

The caisson in down-position is shown by Fig. 5. As sunk, the caisson stands on the extended spuds and the jacks are in position to take bearing on the curbs of the sills. Final line and level of the caisson are obtained by adjusting the spuds and horizontal jacks. To secure an even bed, filling is done by a patented system using two suction tubes to exhaust the water as a water and sand mixture is pumped in, thereby reducing disturbance to local areas and depositing fill material uniformly along the bottom. When filling is complete the jacks are released and removed.

### Caissons coupled under air

The caissons are sunk 3¼ ft. apart between ends. To connect the two ends and open up the tubes, a combination under-water and compressed-air operation is employed. First the gaps at the sides are closed by dropping two bulkheads of steel half cylinders as indicated by Fig. 6. After being placed these half cylinders are filled with tremie concrete.

A diving bell of special shape is then lowered over the roof gap, being guided and protected by the alignment towers on the adjacent ends of the two caissons. A shaft and air lock connect the diving bell with the surface.

Compressed air clears the diving bell of water until the tops of the caisson roofs are exposed, when the ends of the diving bell can be made tight with the half cylinder bulkheads that close the sidewall gaps. The water can then be lowered enough to concrete the closing section of roof slab in air. The diving bell and alignment towers are then removed and the gap closing is completed from inside the caissons. As stated the first outshore caisson was provided with an airlock, Fig. 4, in the outshore bulkhead. Also this first caisson has a shaft to the surface that permits access by workmen. By these means the partly closed gap between

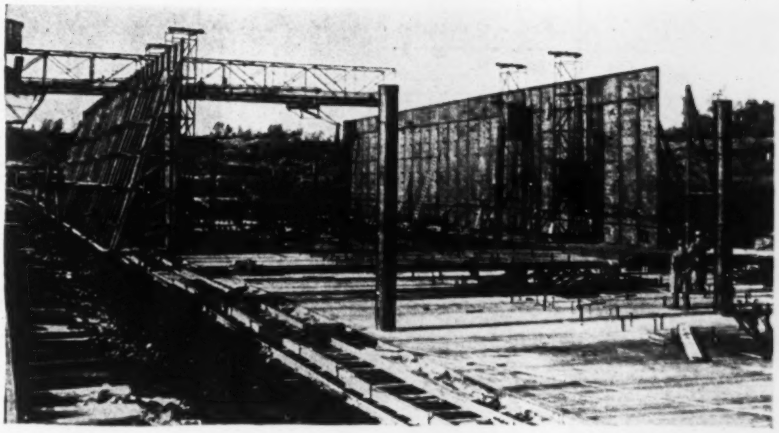


***Fig. 3. Erection of steel shell for caisson in drydock preparatory to placing concrete. Pipes in foreground are two of four wells for jack-operated spuds for vertical adjustment of caisson after it is sunk.***

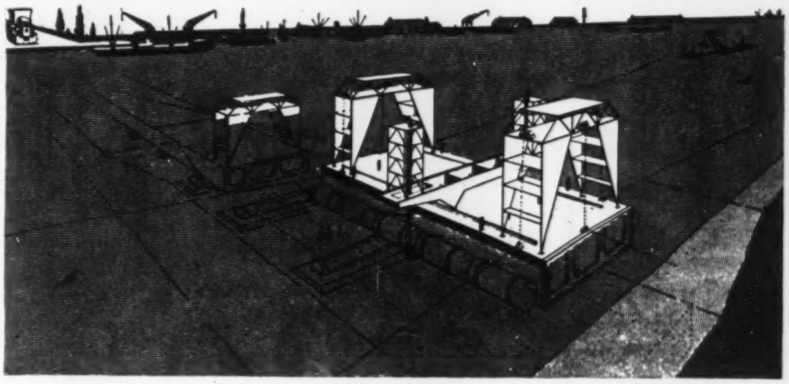
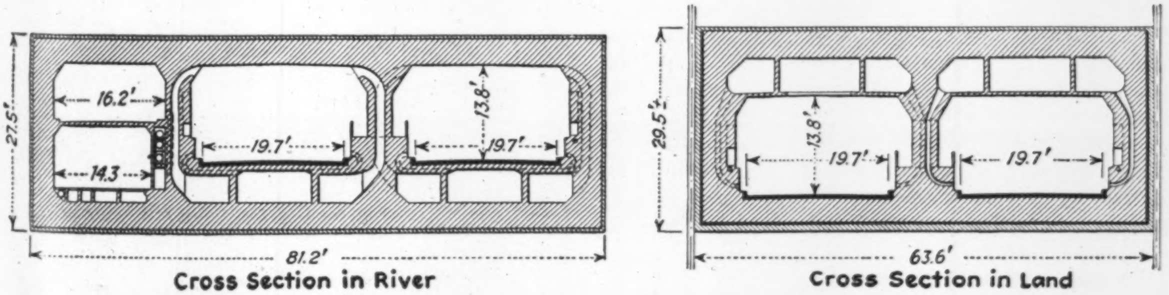


***Fig. 4. Diagrammatic view of sinking of caisson section. Alignment towers carry winches to assist in maneuvering. Odd-shaped machinery in center is for replacing sand fill under located box. Derricks assisting in sinking are not shown.***



**Cross Section in River**

**Cross Section in Land**

***Fig. 2. The river section carries two-lane vehicle traffic in each direction with ample accommodation for cyclist and pedestrians. Escalators are provided at the ventilation buildings for cycle and foot passengers, so the land section of the tunnel carries only vehicle traffic.***

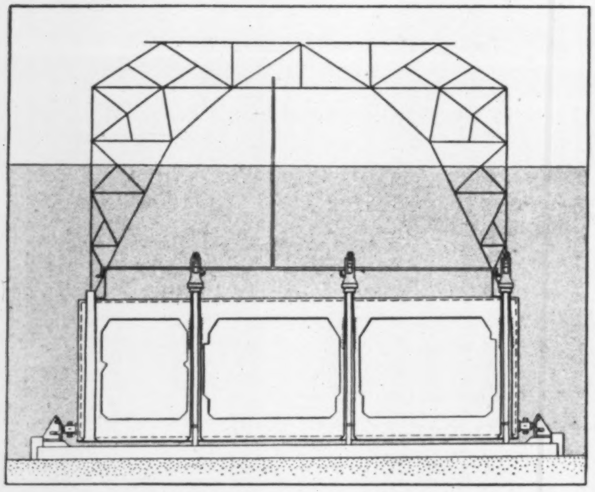


*Fig. 5. Diagrammatic sketch showing alignment towers, concrete sills on bottom of trench and hydraulic jacks for final positioning. Note that spud and jack at left are removed to show condition after underfill is complete.*

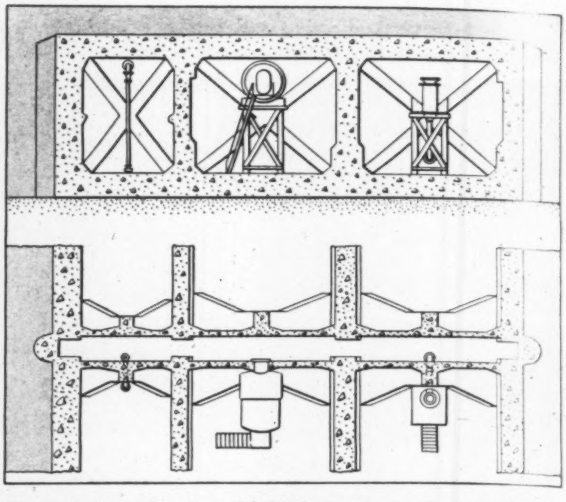


*Fig. 6. Schematic plan of joint between sections. Half cylinder shells filled with concrete by tremie close sides; the top of the tunnel is closed from a diving bell and the bottom is placed by concreting through the man lock in the center.*

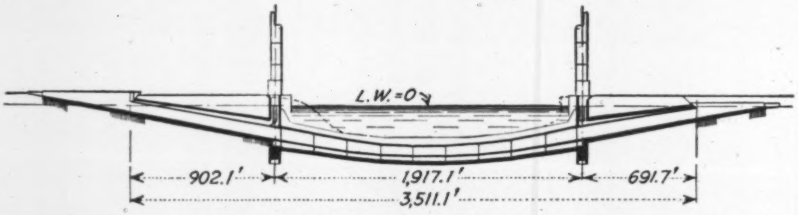


*Fig. 7. Longitudinal section through tunnel. Ventilation buildings, with foundations sunk as pneumatic caissons, serve as connections between precast river section and open cut-and-cover land sections of the tunnel.*

caissons is put under compressed air, and workmen complete the concreting.

Then the bulkheads are demolished with pneumatic tools, the airlock is transported to the next river-end bulkhead, and the trench is backfilled until a covering of 3 ft. over the tunnel is obtained.

### Ventilating shafts and approaches

As shown by Fig. 7 the tunnel is divided into three parts by a ventilating shaft on each shore. The ventilation building foundations are carried 71.7 ft. below low water as pneumatic caissons 110 x 72 x 16 ft. The maximum air pressure was 26 lb. per sq.in., lower than normally required for this depth, due to the fact that the natural groundwater table was lowered by well-points used in constructing the land sections of the tunnel.

The covered land tunnels are constructed in an open pit between lines of steel sheetpiling. On one bank a firm sand was encountered, but on the other a soft clay and peat made it necessary to support the tunnel on piles, reaching down into firm sand. To avoid the risk of driving heavy piles in a deep and treacherous pit they are driven before doing much of the excavation. The Franki cast-in-place type (closed-end steel shell driven and shell withdrawn as concrete is placed) are used, but are filled with concrete only up to the tunnel bottom. The pits on each bank are kept dry by some 20 wellpoints, equipped with submerged pumps. These deliver about 330 gpm each, resulting in lowering the groundwater table about 50 ft. Due to heavy earth pressures the cross braces are shop assembled steel trusses.

### Reasons for a tunnel

Rotterdam, a city of 600,000 people, and one of the principal ports of entry for northern Europe, is separated into two parts by the River Maas. The two sections of the city are now served only by ferries and a single low-level bridge, opened in 1876. Better service is required. A fixed bridge required a clearance of nearly 200 ft. with consequent long and steep approaches in the heart of the city. The usefulness of a movable low-level bridge would be seriously hampered by the water-borne traffic of the River Maas, which forms one of the great harbors of the world. The better solution was a tunnel, and one with two traffic lanes in each direction, a 16½-ft. passage for cyclists and a pedestrian walkway more than 14 ft. wide, all in one structure, was designed. Shallow cover favored caisson method.

The caisson method of tunnel construction was adopted, as the moderate depth required and the sandy material of the river bed favored this method over the usual shield method where shallow cover and sandy soil would result in excessive air loss or more serious difficulties. A single tunnel of considerable width was selected as it required fewer operations in sinking, and reduced the depth of trench necessary. The capacity of the tunnel is estimated at 8,000,000 vehicles annually; cost is a little more than $8,000,000.

Design of the entire undertaking has been made by the Rotterdam Municipal Technical Service with some major revisions made in cooperation with the contractors, Maastunnel Ltd.

# Practice and Problems In Sewage Disposal Service

*Engineers, operators and research workers in the field of sewage disposal met in Chicago on Oct. 3-5 for their first national convention under the auspices of the Federation of Sewage Works Associations. The technical program, focused on problems of current concern, ranged from the announcement that two new chemicals had been discovered for sewage treatment to a plea for sane stream standards. The following extracts from these and other papers which were presented represent a cross-section of present thinking in sewage disposal practice.*

## NEW SEWAGE CHEMICALS

THE CHEMICALS GENERALLY USED in sewage treatment are alum, ferric chloride and lime, chlorinated copperas and ferrisul. Two new compounds developed by the New Jersey Agricultural Experiment Station — sulfalcar and ferrigel—appear to be capable of producing better results at the same cost, or will produce the same results at a lower cost than alum or ferric chloride.

Sulfalcar, an aluminum tetrachloride monosulphate, has been tried on a plant scale following laboratory investigations. Conclusions from this work show:

(1) Sulfalcar applied in equal quantities to alum was superior to alum in that it (a) produced better floc formations; (b) produced better settling floc; (c) clarified sewage containing laundry waste which heretofore could be accomplished with alum only when excessive quantities were used; (d) turbidity removal was greater; (e) suspended solids removal after settling was 12 per cent higher; (f) biochemical oxygen demand removal after settling was 6 per cent higher on normal sewage and 13 per cent higher when laundry wastes were present.

(2) Cost of sulfalcar per ton suspended solids removed and per ton B.O.D. removed was 10 to 15 per cent less than for alum.

(3) Sludge produced from sulfalcar coagulation was denser and compacted better than that from alum treatment.

***Two new chemicals for sewage treatment were described by Willem Rudolfs.***

Ferrigel, the other new chemical, is a compound made from ferric chloride and gelatine, glue or certain proteins. It dissolves readily in sewage and acts rapidly. General conclusions from experimental work are: Ferrigel produces a large, strong, heavy, frequently ball-like floc which settles quickly. It reduces the amount of ferric chloride for coagulation about 40 per cent. It is effective over a pH range of 4.5 to 8.5, and produces an effluent of unusual clarity.

Sludge obtained with ferrigel treatment is more dense and compact than that obtained with ferric chloride. Of special importance is the fact that ferrigel sludge can be dewatered without further additions of chemicals to produce a dry cake quickly with a sparkling, clear effluent. Tests with this material on sulphur-black and aniline dye wastes show that any strength of the waste could be completely clarified, and the resulting sludge was readily dewatered.—Willem Rudolfs, *Chief, Depart. of Water and Sewage Research, Agricultural Experiment Station, New Brunswick, N. J.*

## PUMPS FOR SEWAGE SERVICE

Buying and selling of sewage pumps has usually been done on the basis of guarantees of high efficiency. Generally speaking, high efficiency of such a pump is a matter of small moment. The important requirement is the average efficiency over a period of years, and a freedom from attention and repairs.

Wearing rings are a source of serious losses of efficiency and capacity of sewage pumps. Cast iron has been tried for stationary and rotating rings. Bronze has been used for rotating rings in combination with a cast iron stationary ring. In general, the most satisfactory results have been obtained by the use of a hard, abrasive, resistant material. A hard surface has been obtained by the use of the nitridation process, and rotating rings of this material have been used with a considerable degree of success in combination with a cast iron stationary ring.

All of the pumps at the North Side plant of the Chicago Sanitary District have now been equipped with rings of cast iron, the wearing surface of which has been sprayed to a depth of about 1/16 in. with a high chrome, high carbon steel which air hardens to Brinell hardness of over 400.—Lloyd M. Johnson, *Engineer of Maintenance and Operation, Sanitary District of Chicago.*

*Discussion*—Manufacturers of sewage treatment equipment and accessories have been alert to supply those mechanisms which the designing engineer needs. And they are gradually getting away from the practice of attempting to make devices developed for use in other fields serve the exacting requirements of waste treatment. One of the pet peeves which bothers the writer in respect to the subject of equipment relates to the character and lack of information in some trade catalogs. Too many effusions of the manufacturers of equipment seem to be aimed at the school child rather than at the designer and purchaser. For instance, data of specific performance are too seldom stated and indication of costs almost never. — CHARLES GILMAN HYDE, *Professor of Sanitary Engineering, University of California, Berkeley, Calif.*

### SLUDGE GAS MOTOR FUEL

Sludge has been used resourcefully as a motor fuel to some extent abroad, although this practice necessarily is limited to localities where gasoline is expensive. In Johannesburg, South Africa, for instance, sludge gas is used for motor truck use. Gas passed through water under pressure to eliminate carbon dioxide is compressed to 5,000 lb. per sq.in. in steel cylinders attached to a truck. With 19 cu.ft. of gas (containing 72 per cent methane) a truck can operate for a distance of one mile. Since the same truck operates for nine miles on one gallon of gasoline, it can be calculated that 171 cu.ft. of sludge gas is equivalent to one gallon of gasoline. A cylinder of compressed gas will operate a truck for a distance of 131 miles.—RALPH F. FUHRMAN, *assistant superintendent, Sewage Treatment Plant, Washington, D. C.*

### STREAM STANDARDS

Virtually every city in the United States will be concerned in the next two decades either with increasing the degree of treatment for sewage or with providing treatment facilities now wholly lacking. Expenditures for this purpose will probably exceed a billion dollars. No more important problem confronts the profession than how to steer a reasonable course between the perfectionist and the opportunist in this difficult field.

Increases in knowledge regarding the effects of waste discharges into receiving bodies of water have produced a literal flood of standards of cleanliness during the past ten years. These questions arise: Are the standards now being promulgated with increasing velocity and perhaps decreasing validity on an adequate scientific and practical basis upon which the case for sewage treatment is to rest? Can the standards be met? Should they be met? Does the expenditure of the sewage treatment dollar rest upon a reasonable balancing of convenience and of public service?

The federation should stimulate studies directed toward the values to be received by the adjustment of stream quality through the forces of sewage treatment. A limited number of follow-up reviews have been made of streams on which corrective measures have been established. Additional studies are needed to build up substantiating data for the promises made and for the development of practicable criteria for future enterprises. How far has that promise been met by fulfillment and at what cost?—ABEL WOLMAN, *Professor of Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.*

***Prof. Abel Wolman: "Sanitas sanitatum . . . is a good slogan."***

### INDUSTRIAL WASTE DISPOSAL

Cost is an important item in industrial waste treatment, and this is especially true in regard to facilities for small industries. In order to meet this requirement the Lancaster Iron Works has built a so-called "package" unit. To handle milk product factory wastes, for example, they have developed a fabricated steel treatment plant consisting of two tanks. One of these units is a hopper bottom tank for aeration of waste; the other unit is a hopper bottom settling tank. Chemical dosing equipment, air compressors, pumps and all other necessary equipment is housed in the lower portion of the units under the hoppers. About 24 hours is required to set up a plant and place it in operation. The life of the steel tank is said to be from 20 to 25 years, and the cost is about 50 per cent of that of concrete structures of the same capacity.—E. S. ELDRIDGE, *research associate, Michigan State College Engineering Experiment Station, East Lansing, Mich.*

### GARBAGE-SEWAGE DISPOSAL

On the basis of available data, the present status of combined garbage-sewage treatment disposal would appear to be as follows:

1. Research results give every indication of workability. But conclusions concerning the practicability of dual disposal on a large scale must be considered as tentative and subject to modifications revealed by actual plant experiences. There is still much to be investigated regarding the effect of garbage on treatment processes and capacity requirements.

2. Practically nothing is known about the cost of handling garbage through a sewage treatment works.

3. Even if we had the complete answer as to the workability and cost of the process, the acceptance of dual disposal by a community must be made contingent upon a careful economic study of the entire problem of refuse disposal. Disposal of garbage is only one element of this problem, leaving for further consideration the disposal of rubbish and ashes. The latter constituent may account for 75 per cent by weight of the total community waste. Incidentally, the removal of garbage from refuse may complicate incinerator operation because of the high temperatures produced when rubbish alone is burned. —EDWARD J. CLEARY, *Associate Editor, Engineering News-Record, New York City.*

*Discussion* — Dual disposal like other engineering problems ultimately simmers down to a consideration of economics. There is no method or combination of methods of municipal waste treatment generally applicable to all conditions. Each decision therefore, must be based upon a careful analysis of the requirements and a comparative study of the various practicable means of meeting them, each estimated as to cost, and all evaluated on a common basis of accomplishment and annual cost.

One of the best means of avoiding pitfalls in pioneer work is to provide liberal factors of safety or, if you please, factors of ignorance in the design of dual disposal systems. For illustration, at Gary, sludge digestion capacity has been provided in the amount of 9 cu.ft. per capita. Similarly, the area of the digestion tanks has been made large and the depth relatively shallow in order to minimize the effect of the violent gassing. —L. R. HOWSON, *Alvord, Burdick & Howson, consulting engineers, Chicago, Ill.*

### PURIFICATION ROLE OF TRICKLING FILTERS

With coarse-grained filters, short dosing cycles are conducive to a more uniform rate of discharge and materially increased efficiency. The more uniform the rate of discharge from a filter the closer is the approach to the maximum efficiency of the unit for the load which it is receiving. Highly concentrated wastes, with B.O.D.'s up to 3,000 ppm have been effectively treated by series filtration with a settling tank interposed between the filters for the purpose of removing agglomerated colloidal and finely suspended matter effected by a washable or coarse-grained high rate primary filter.

Emphasis on the nitrification properties of filters, in the past, has been an important factor responsible for failure to recognize the tremendous capacity of filters to remove B.O.D. constituents by their agglomerating properties.

Fine-grained trickling filters of the washable type and coarse-grained high rate filters may be effectively employed for the removal of large quantities of B.O.D. constituents or for the reduction of excessive fluctuations in concentrations of wastes reaching a final process of purification—activated sludge or final trickling filter treatment. Removal of 4,000 to 6,000 lb. of B.O.D. per acre-ft. is feasible with fine-grained, shallow, washable or with coarse-grained, deep, high-rate trickling filters combined with pre- and post-clarification. —MAX LEVINE, *Professor of Bacteriology, Iowa State College, Ames, Iowa.*

### SLUDGE DEWATERING

There are more than a dozen different types of sludges produced in sewage treatment plants. Effective disposal of this sludge usually demands that it be dewatered, except in special cases, to a moisture content of 65 to 75 per cent. Sand beds are effective for this purpose, but have limited use. Conditioning with chemicals and dewatering on vacuum filters, has become accepted practice and has shown rapid development. While the general procedure has become standardized, there is still much to be learned relative to detail, and like all pioneer endeavor, the whole matter, is still more or less empirical. From data in hand, it is apparent that all types of sludges, unless complicated by exceptional circumstances, can be dewatered by this method. These data, however, show such wide fluctuations that any conclusions drawn must be made with reservations.

The selection of chemicals to use, is fairly well standardized, but the proper amounts are still more or less a matter of trial and error. Whether or not to use ferric chloride alone or in combination with lime is still problematical in some instances, at least. There is not only the cost factor (one per cent ferric chloride is equivalent in cost to about three to three and one-half per cent CaO), but also for any given type of sludge, the effects of such factors as composition, concentration, uniformity, season and temperature.—F. W. JONES, *Havens and Emerson, Consulting Engineers, Cleveland, Ohio.*

*Discussion* — Preliminary returns from a survey of 94 plants dewatering sludge on vacuum filters indicates the following: filters not in operation, 10; using paper pulp, 1; using alum, 1; using lime, 3; using ferric sulphate, 2; using chlorinated copperas, 2; using ferric chloride, 38. Thus, of the plants which reported the use of conditioning chemicals, 85 per cent employ ferric chloride.—HARRY A. FABER, *Research Chemist, The Chlorine Institute, New York City.*

**Sam Tolman of the Jeffrey Mfg. Co. with program chairman C. K. Calvert of Indianapolis.**

### ACTIVATED SLUDGE PLANT OPERATION HINTS

Best aids to operation of an activated sludge plant are the control of the dissolved oxygen in the aeration tanks, use of the sludge index, microscopic examinations and the daily chemical analyses. Dissolved oxygen, the sludge index and concentration of solids depend upon the characteristics of the sewage and sludge, and these will vary considerably among well-operated plants. For example, at the Chicago North Side plant the liquor leaving the aeration tanks should contain 2 ppm of dissolved oxygen. At Wards Island it has been found desirable to have it about 5 ppm at all times. The sludge index averaged 1.7 at Tallmans Island, 1.37 at the Chicago North Side plant, 0.66 at Wards Island and about 0.50 at San Antonio.

The concentration of solids permissible in the aeration tank depends largely upon the settling qualities of the sludge. The better the sludge settles the higher may be the concentration of solids. Optimum concentration, however, is still a matter of opinion. Actual values vary from an average of slightly more than 600 ppm at Providence to about 4,000 at Milwaukee, with an average at many plants between 1,500 and 2,500 ppm. At Wards Island best results are obtained with about 1,500 ppm.—G. P. EDWARDS, *Sanitary Chemist, Dept. of Public Works, New York City.*

*Discussion*—The definition of the sludge index stated in Standard Methods gives it in a volumetric measurement and, as far as I have been able to determine, is not comparable with any other data obtained for or used in plant operation. If, however, the sludge index is expressed as the concentration of sludge in the bottom of the cylinders, this can be compared directly with the concentration of the return sludge. This is the method of expression used by Dr. Edwards. There is one rule that we have established for activated sludge plant operation and that is this: The return sludge concentration must never be allowed to exceed the sludge index (expressed as per cent solids). This has proved an excellent guide, as following this rule does not permit the retention of sludge in the settling tanks long enough to become damaged.—DON E. BLOODGOOD, *Manager, Sewage Plant, Indianapolis, Ind.*

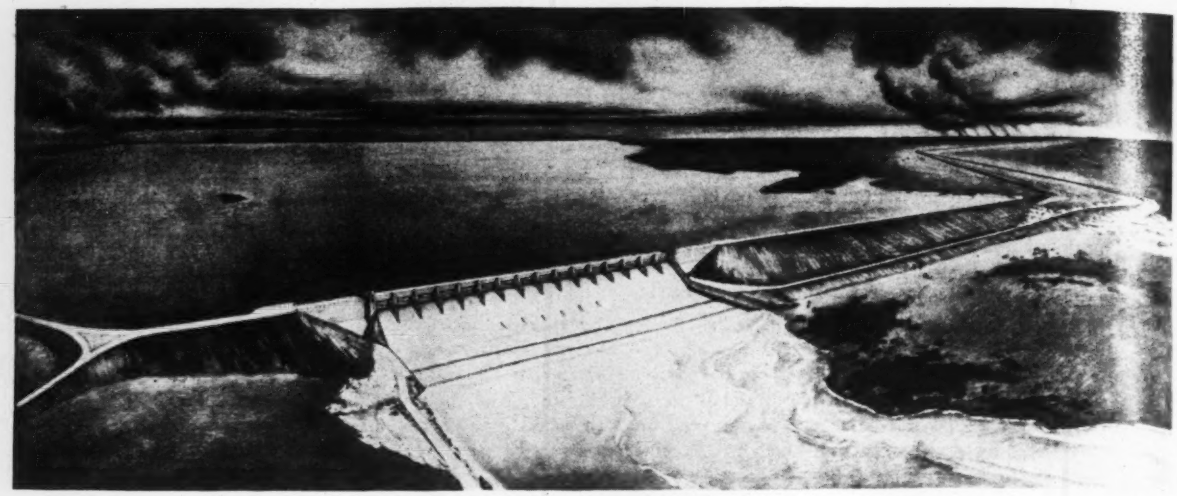


Fig. 1. John Martin Dam, newest of Great Plains flood control projects.

# The John Martin Reservoir Project

**Contents in Brief**—*John Martin Dam (formerly Caddoa Dam) on the Arkansas River in southeastern Colorado, is one of the series of large projects being built for flood control and water conservation in the Great Plains area. The project, which will reduce all floods of record in the upper river to a maximum of 10,000 cfs, includes a combination concrete and earthfill dam with overflow spillway, 20 miles of relocation of main line of the Santa Fe Ry., minor highway changes, abandonment of the village of Caddoa, and special flood protection for the Fort Lyon veterans hospital located in the upper limb of the reservoir area. The railroad work is well along and dam construction is past preliminary stage, contract was awarded in July.*

JOHN MARTIN DAM, formerly known as the Caddoa Dam, on the Arkansas River in southeastern Colorado, is one of the principal projects in the extensive flood control and stream regulation undertaken by the U. S. Corps of Engineers in the Great Plains area. The dam, located on the main river 58 miles west of the Kansas line, will assure the fertility of the rich irrigated valley now dependent upon a highly erratic streamflow. Devastating floods, such as occurred in 1921, will be tamed to a maximum of 10,000 cfs (bank capacity) below the dam.

The structure to be built will consist of a concrete overflow section in the river channel, a rolled-fill embankment across the flood plain, and two long earth wing dams. Maximum height is 130 ft. above the flood plain; the overall length is 14,000 ft. A major auxiliary item is the relocation of 20 miles of main line for the Santa Fe Ry. from its present valley bottom route to the sand dune area forming the south bench of the valley. This work is now in progress under a million-dollar contract to the Western Contracting Corp. of Sioux City, Ia. Bids for the main dam were received on July 12. The contract was awarded to W. E. Callahan Const. Co., Gunther & Shirley Co., and Rohl-Connolly Co., Los Angeles, for $7,160,754.

The project was authorized by the Flood Control Act of June 22, 1936. Nearly $7,000,000 has been allotted for the work, though additional funds will be necessary for completion.

### General features

Above the dam the Arkansas River drains a watershed of 18,910 sq. mi., including some 6,000 sq. mi. of rugged mountains in the high Rockies. The character of the mountainous headwater area, coupled with a river slope of 110 ft. per mile on the upper reaches, results in flash floods of considerable magnitude. Much valuable floodwater has heretofore been lost for irrigation purposes. Some of these floods, such as the one in June. 1921, devastated large areas. Records show the mean annual runoff at the damsite over the 23-year period of 1914-1937 has been about 315,000 acre-ft.: minimum was 89,000 acre-ft. in 1934, maximum was 1,073,000 in 1921. The 1921 flood produced a maximum discharge of 170,000 cfs at Caddoa, and the runoff was estimated at 555,400 acre-ft. At times the stream is practically dry; the average flow is around 400 cfs. Precipitation ranges from 12 in. per year at the dam to 25 in. in the mountains.

To control and regulate this erratic flow the John Martin project has been designed with a reservoir capacity of 655,000 acre-ft. at maximum pool level. The maximum pool elevation was set at El. 3870, since a higher pool would have materially increased the protective work required at the Fort Lyon hospital upstream. The upper 19 ft., or 270,000 acre-ft. capacity will be reserved for flood storage. Below El. 3851 will be a storage capacity of 385,000 acre-ft. available for irrigation. Estimates place the maximum possible flood at 650,000 cfs, and the overflow spillway has been designed to pass such a discharge.

The reservoir, extending 14 miles upstream, lies mostly in the flood plain of the river. Much of the irrigated farmland in the vicinity is on a bench to the north, and very little of it will be inundated. The village of Caddoa, pop. 100, will be abandoned, as also will 3.5 miles of county road. Special protection works will be built around the U. S. veterans' hospital at Fort Lyon in the upper end of the reservoir, as this institution is too valuable to be abandoned or relocated. South of the flood plain the reservoir will cover sand dune areas containing little of value except the Santa Fe Ry.

Investigation of the damsite included 129 2-in. core drill holes aggregating 8,024 ft.; three 6-in. holes totaling 387 ft.; two 36-in. calyx drill holes each penetrating about 50 ft. into rock; a 16x16-ft. pit 50 ft. deep, sheeted with steel piling; a number of trenches and pits dug through the overburden; and extensive seismic explorations with the Shepard type seismograph. The present river channel is at the south side of a flat flood plain about 4,000 ft. wide. The groundwater table is about 5 ft. below the general surface of this plain. For the most part the flood plain consists of 4 to 14 ft. of sand, clay and silt overlying a porous stratum of sand, gravel and boulders. About 25 ft. below the valley floor is a layer of sandstone averaging 40 ft. thick, which overlies a deep shale formation. Meandering across the center of the flood plain is a prehistoric river channel, scoured about 25 ft. deep into the rock.

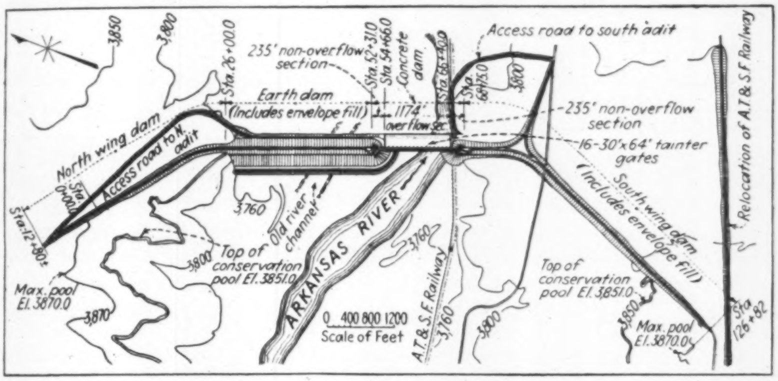

3,850
3,800
Sta. 26+00.0
235' non-overflow section
Sta. 52+31.0
Sta. 54+66.0
Concrete dam
Sta. 66+40.0
Access road to south adit
Sta. 68+75.0
3,800
Earth dam (Includes envelope fill)
1174' overflow sec.
235' non-overflow section
16-30'x64' tainter gates
North wing dam
Access road to N. adit
Sta. 0+00.0
Sta.-12+80±
3,760
Old river channel
ARKANSAS RIVER
South wing dam (Includes envelope fill)
Relocation of A.T. & S.F. Railway
Top of conservation pool El. 3851.0
3,800
Max. pool El. 3870.0
3,870
0 400 800 1200 Scale of Feet
3,760
A.T. & S.F. Railway
3,760
3,800
Top of conservation pool El. 3,851.0
3,850
Max. pool El. 3870.0
Sta. 126+82

**Fig. 2. The dam is a combination of concrete gravity overflow section, topped by tainter gates, four-million-yard main embankment across flood plain, and two long earth wing dikes.**

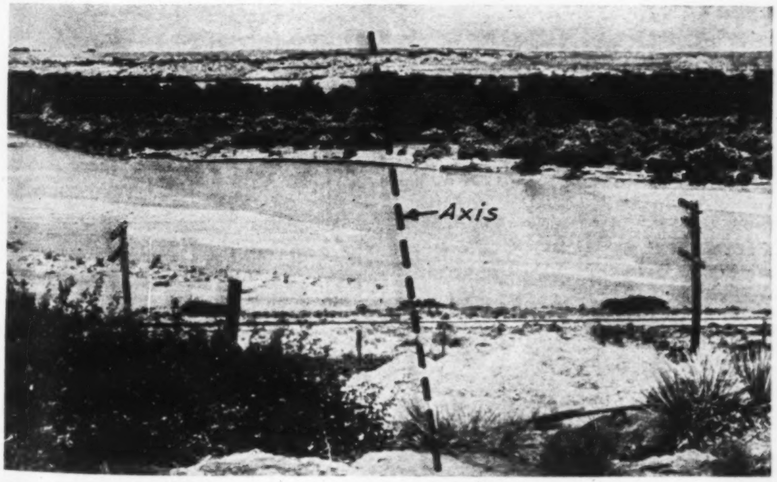


**Fig. 3. Site of John Martin Dam is wide flood plain on Arkansas River, bordered by steep escarpment on the north (upper center) and sand dunes on the south.**

The north side of the flood plain is defined by a steep sandstone escarpment about 100 ft. high which forms the farmland bench. To the south is a 50-ft. shale and sandstone bluff, topped by sand dunes. The main line Santa Fe railroad relocation, being built by the government, runs through these dunes.

To stabilize the shifting dunes along the relocated railway the army engineers, in cooperation with the Soil Conservation Service, are mulching the exposed sand areas with straw, followed by seeding with native grass. This work is already showing favorable results. It is interesting to note that this stabilization program has eliminated the necessity for a costly relocation on the north side of the river, which would have involved two major crossings of the river and would have traversed expensive irrigated lands.

Careful study of the physical features of the site, the foundation conditions and materials available, together with comparative cost analyses of various types of dams, led to the adoption of a combination concrete and rolled earthfill structure. Principle quantities involved include: foundation excavation, 975,000 cu. yd. common, 125,000 cu. yd. rock; earth fill, 5,915,000 cu. yd.; rock fill, 220,000 cu. yd.; concrete, 557,000 cu. yd.

### Structures

In the present river channel will be a concrete dam, consisting of an ogee overflow section 1,174 ft. long, surmounted by 16 tainter gates 30x64 ft., and flanked by a non-overflow section 235 ft. long at each end. The tainter gates will be of all-welded construction, the first of this type of fabrication. The south non-overflow section ends at the south bluff; the north section ties into the earth embankment across the flood plain. Bottom of concrete dam will be in rock, about El. 3730; spillway lip is El. 3840; top of non-overflow section is El. 3880, the same as the earth dam. Concrete training walls define the spillway area at the sides, and extending 183 ft. downstream from the toe of spillway is a concrete-paved stilling basin containing two rows of concrete baffle blocks.

For release of irrigation water and reservoir regulation for flood control, two 4x4-ft. and six 6x7½-ft. conduits will be placed in the spillway section of the dam, with centerline at El. 3768. All discharge will be controlled by slide gates located in a gallery within the dam. These outlet works will discharge 12,600 cfs with the pool at El. 3851.

No artificial cooling of the mass concrete is specified, but the aggregates will be precooled by sprinkling and the concrete mixing water will be refrigerated in the summer to keep the placing temperature of concrete below 75 deg. Also, no concrete will be placed between 8 a.m. and 4 p.m. from June 1 to Sept. 15. The government has already awarded a contract to the Colorado Portland Cement Co. for the 550,000 bbl. of moderate-low-heat portland cement required for the project. The tri-calcium silicate content of the cement is limited to 50 per cent to reduce the heat of hydration.

Concrete aggregates are available in deposits in the north bench upstream from the dam. Two sizes of sand and four of gravel up to 6-in. cobbles will be used. The gravel pit will produce a large excess of sand, which may be placed in the pervious sections of the embankment.

Forms for all exposed concrete surfaces will be lined with absorptive material. The army engineers have followed the tests conducted by the U. S. Bureau of Reclamation on the use of this material, and the Caddoa district has done considerable experimenting under field conditions on its own work, particularly on unexposed parts of structures on the railway relocation. Reports of tests and investigations state that, while the absorptive form lining is still far from perfect, its use results in greatly improved quality and appearance of the concrete, producing a case-hardened surface and a substantial reduction of voids for a depth of 1½ in.

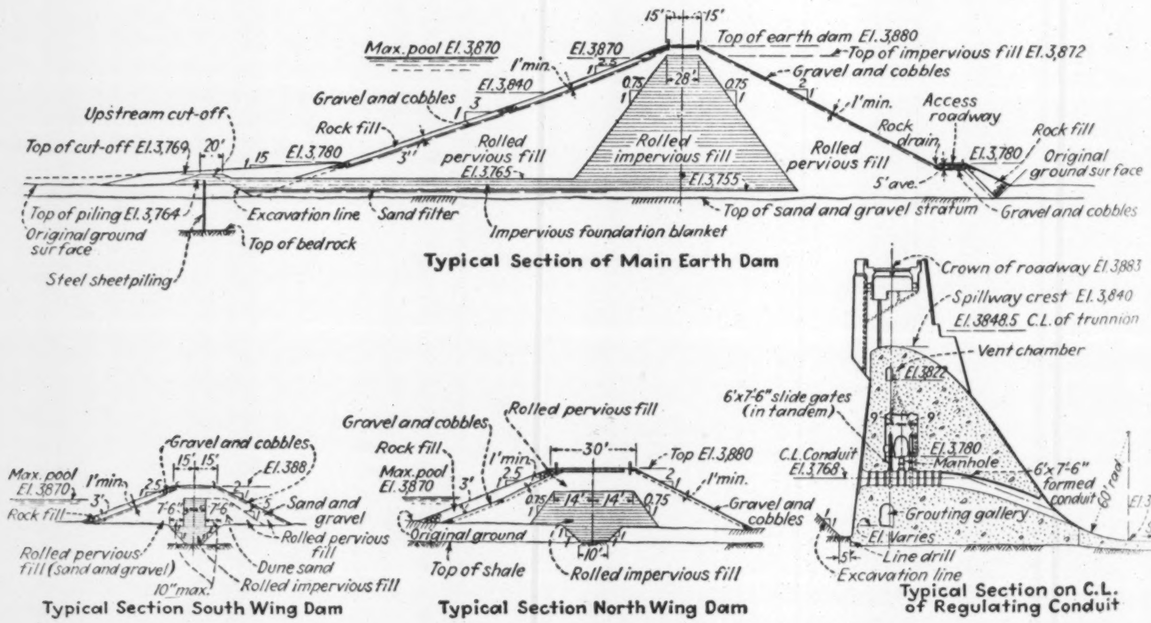
### Main embankment

The main embankment, averaging 130 ft. high above the valley floor, will rest on the sand and gravel stratum from which the clay overburden has been stripped. Side slopes are 2½: 1 and 3: 1 upstream and 2: 1 downstream. A wide central core will be of rolled impervious material, and an impervious blanket 10 ft. thick, laid on the gravel foundation, extends upstream to a steel sheetpiling cutoff wall, which also forms the cofferdam for the earth section of the dam. Rolled pervious fill forms the shells of the embankment, and both slopes will be covered by a 12-in layer of gravel and cobbles. A rock blanket of 3 ft. minimum thickness will be placed over the gravel on the upstream slope.

The sheet steel cutoff wall in the upper cofferdam will be driven to rock to minimize seepage through the porous foundation of the earthfill. Experience with the 16x16-ft. test pit, which was sheeted with steel piling, showed that the sheetpiles can be driven through the sand and gravel, and even through boulders, as they are of soft rock. Pumping tests in this and other pits proved that the groundwater table can be lowered in local areas by pumping, though it runs uniformly throughout the flood plain. Percolation through the gravel is slow enough to assure keeping the embankment foundation area dry for placing impervious base material. The main embankment, about 2,600 ft. long, contains over 4,000,000 cu. yd. of fill.

Extending out over the north bench is the north wing dam or dike, 3,900 ft. long, containing an impervious rolled fill core with pervious shells. About 2,000 ft. of the core is carried down into a trench excavated to shale; for the remaining length of dike no cutoff is provided as the impervious overburden increases the percolation path until seepage is negligible. Side slopes of the dike are 2½: 1 upstream and 2: 1 downstream. It will require about 125,000 cu. yd. of fill.

Enveloping the south end of the concrete dam and extending for 5,700 ft. out into the sand dunes is the south wing dam, 100 ft. in maximum height. This section consists of an impervious rolled fill core in a trench excavated to shale, a sand and gravel shell upstream, and a downstream shell of dune sand protected by a heavy covering of sand and gravel. Both wing dams have the same slope


15'
15'
Top of earth dam El. 3,880
Top of impervious fill El. 3,872
Max. pool El. 3,870
El. 3,870
1'min.
2.5
Gravel and cobbles
El. 3,840
Gravel and cobbles
3
Upstream cut-off
Rock fill
0.75
28'
0.75
2
1'min.
Access roadway
Top of cut-off El. 3,769
20'
15
El. 3,780
3'
Rolled pervious fill
Rolled impervious fill
Rolled pervious fill
Rock drain
Rock fill
El. 3,780
Original ground surface
El. 3,765
El. 3,755
5' ave.
Top of piling El. 3,764
Excavation line
Sand filter
Top of sand and gravel stratum
Gravel and cobbles
Original ground surface
Top of bedrock
Impervious foundation blanket
Steel sheetpiling
Crown of roadway El. 3,883
Spillway crest El. 3,840
El. 3848.5 C.L. of trunnion
Vent chamber
El. 3822
6'x7'-6" slide gates (in tandem)
9'
9'
C.L. Conduit El. 3,768
El. 3,780
Manhole
6'x7'-6" formed conduit
60' rad.
El. 3732.45
Grouting gallery
Slope
El. Varies
5'
Line drill
Excavation line
Gravel and cobbles
15'
15'
El. 388
Max. pool El. 3,870
1'min.
2.5
2
3'
7'-6"
7'-6"
5
Sand and gravel
Rock fill
Rolled pervious fill
Rolled pervious fill (sand and gravel)
Dune sand
10" max.
Rolled impervious fill
Gravel and cobbles
Rolled pervious fill
Rock fill
30'
Top El. 3,880
1'min.
Max. pool El. 3,870
3'
2.5
2
1'min.
0.75
14'
14'
0.75
Gravel and cobbles
Original ground
10'
Top of shale
Rolled impervious fill

Typical Section of Main Earth Dam

Typical Section on C.L. of Regulating Conduit

Typical Section South Wing Dam

Typical Section North Wing Dam

**Fig. 4. Typical cross-sections of the concrete structure, main embankment and wing dikes. Note the location of steel sheetpile cutoff wall in the upstream cofferdam of the earth dam.**

protection of gravel and cobbles as does the main dam, including the additional riprap facing on the upstream slopes. The south wing dam will contain about 1,300,000 cu. yd. of fill.

Rock at the site is not suitable for riprap, but a sandstone quarry has been located 4 miles west of the dam on the old railroad line, and a ledge of suitable limestone exists on the bench 7 miles to the north. Gravel and cobbles for the slope protection will come from the aggregate and borrow pits.

The river will remain in its present channel during construction of the base for the north half of the concrete dam in the first cofferdam. Then the stream will be diverted through low monoliths and outlet conduits in the north half while the south half base is being built in a second cofferdam. Diversion for the remaining construction will be through low monoliths and the outlet works which by that time will be installed in the full section of the concrete dam.

Except for the permanent upstream cofferdam at the main embankment, which is really part of the dam structure, in that it contains the cutoff wall, the design, construction and maintenance of the cofferdams are entirely the responsibility of the contractor, and he takes all the risk of possible flooding.

The new Caddoa District has been formed by the U. S. Engineer Dept. for the construction of the John Martin project and the operation of Conchas Dam, formerly a separate district, all under the Southwestern Division at Little Rock, Ark. Major James H. Stratton is district engineer at Caddoa. Attractive district headquarters of adobe brick construction have been built on the bench at the north end of the dam. The John Martin project is scheduled for completion in the summer of 1943.

# Housing Builders Called on for $400,000,000 Investment

**C. F. Palmer**
Coordinator of Defense Housing
Advisory Commission on National Defense, Washington

OUR DEFENSE HOUSING PROGRAM is based on the premise that sufficient housing, private or public, is made available to meet emergency needs with such dispatch that national defense does not suffer. Speed is paramount, but speed is not incompatible with adequate standards. The program can create neighborhoods which contribute to decent living.

### Providing for housing

Housing is needed for families of enlisted personnel, families of civilian employees and some single civilian employees of the Army and Navy, and for families and single employees in private industry engaged in defense production. This need is being met in several different ways.

Private housing is expected to provide for permanent needs. Nothing will be done that might prevent private building from fulfilling this obligation. The entire field of housing for sale is being left to private capital, while governmental operations are confined to rental projects. As private housing increases, the government's operations will correspondingly contract.

### RFC-FHA housing

The RFC Mortgage Co. is ready to use $10,000,000 equity capital so that government housing projects can be undertaken immediately. Mortgages on such projects insured by FHA's rental division can supply $40,000,000 more, making a total of $50,000,000 available. Options have been signed or are being negotiated in 14 areas on both coasts where there is reasonable likelihood that these rental developments can be absorbed permanently. Subsequent resale by the RFC Mortgage Co. to private interests is planned as rapidly as possible.

### FWA emergency housing

Temporary housing beyond the range of private initiative requires government construction. The Lanham Act, which provides $150,000,000 for the purpose, places administrative responsibility in the Federal Works Agency. Farm Security may cooperate where such housing has future rural use, and WPA will be available for construction of utilities. Self-sustaining rents are to be charged for this housing.

Finally, defense housing needed for families unable to pay commercial rents, and particularly for families of enlisted personnel and low-income industrial workers, is to be built mainly by local housing authorities under USHA subsidy.

The best-defined needs for defense housing are those reported by Navy and Army. These agencies will build and manage most of their projects, though the Army will make more use of other federal agencies for construction than will the Navy.

### Available housing money

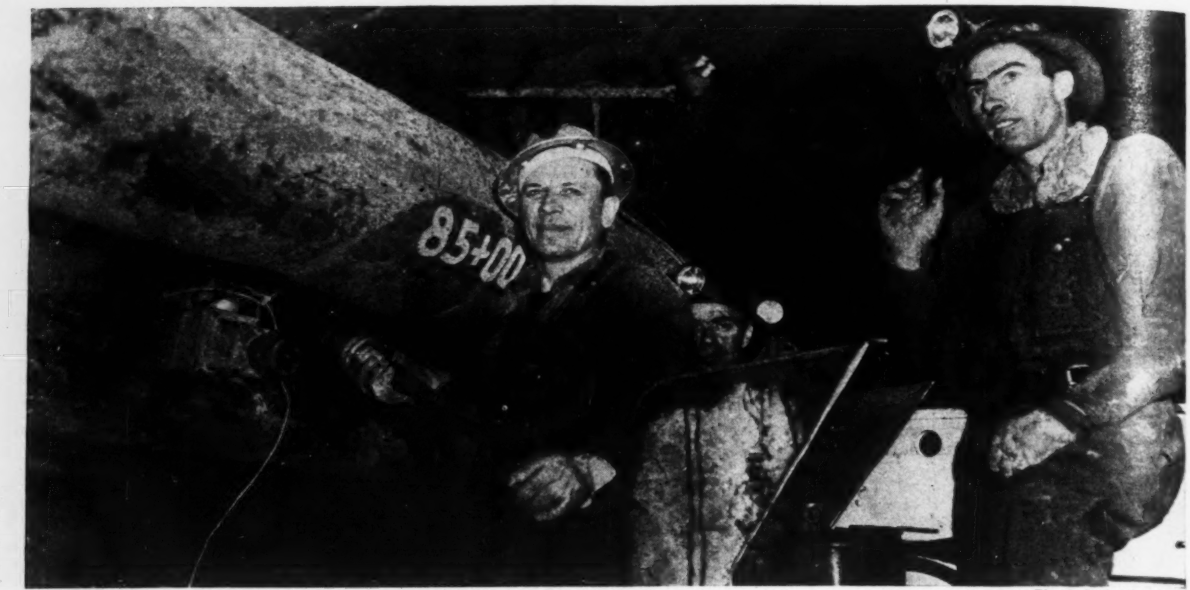
Funds for all this construction are provided by $100,000,000 appropriated in the second supplemental defense bill beyond the $200,000,000 referred to above. After repayment by the RFC of its $10,000,000 to the emergency fund there is left $290,000,000 to build new houses.

With the first part of this money the Navy has been allocated funds to build 13,340 dwelling units, Army 13,900 units, to provide for low-income civilian and enlisted families in the service. But the total need is very much greater than these 27,240 units. The facts indicate it to be 160,000 to 200,000 units, which at an average cost of $3,500 will require a total investment of $700,000,000. As government money provides only $290,000,000, it is clear that private enterprise has a large part to play.

### Activities coordinated

Coordination is assured by having land purchases handled by one negotiator instead of five. Promiscuous purchase of materials is also on the way out; centralized buying for thousands of units is planned and already taking its place.

One dollar per dwelling unit saved, with 27,240 now in the works means $27,240 more to provide additional housing.



Thos. J. Barbre Photo

*Fig. 1. Firing a blast from locomotive 110-volt storage battery, Carlton Tunnel*

# Fast Tunnel Driving at Carlton

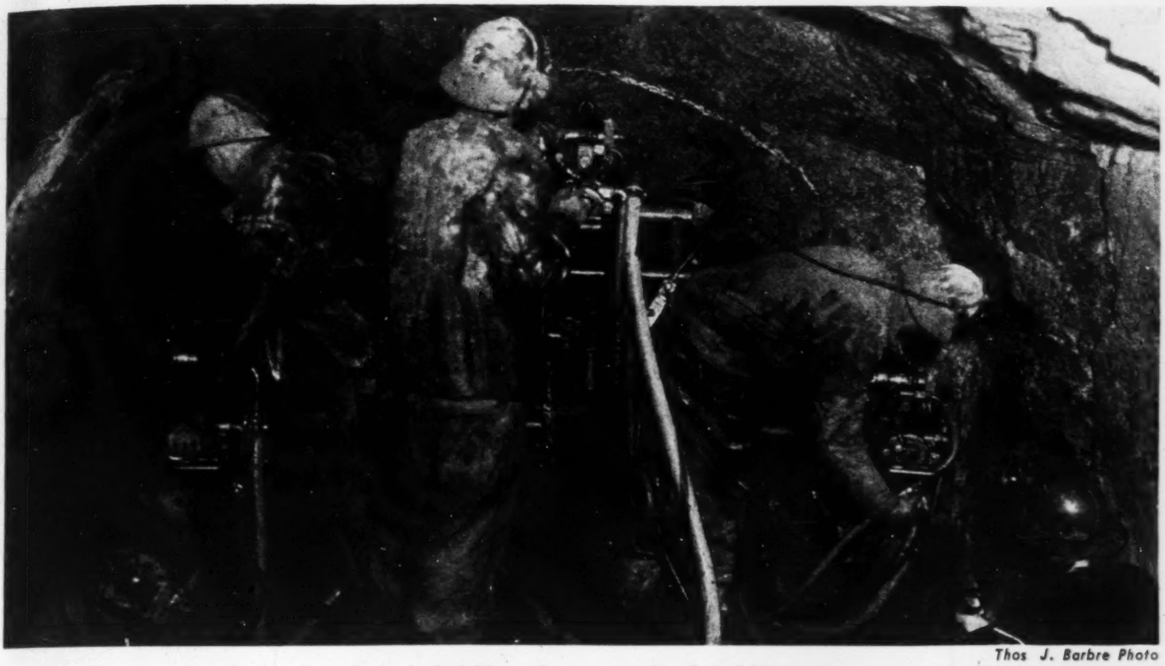
**Contents in Brief**—*A world's record advance of 1,879 ft. from a single portal heading in a 31-day period was established at Carlton Drainage Tunnel in Colorado last spring. This progress, 60.6 ft. per day, is indicative of the general tempo of the work which, over a period of months, has averaged more than 50 ft. daily. Good equipment, a fine organization and a bonus system are responsible for the fast work. Details of procedure are given in the following article.*

FORMULA FOR FAST TUNNEL DRIVING: Select a tunnel for drainage purposes, to be left unlined, so there will be no worry about overbreaks or tight spots, located in a remote mountain section where muck disposal is no problem; make it about 6 miles long to afford the best of equipment and about 10x11 ft. in size for economical and efficient driving; choose a good hard ground, such as Pikes Peak granite that drills and breaks nicely and requires no timbering; drive it from a portal on a 0.3 per cent upgrade to eliminate hoisting and pumping; build up a crack organization headed by an oldtimer with young ideas, like "Long John" Austin; offer an attractive bonus to the crews and then sit back and watch the muck fly. The only worry will be to keep the boys from running out of Hasting powder.

This is the set-up at the 6-mile Carlton Drainage Tunnel near Cripple Creek, Colo., where the amazing progress of 1,879 ft. was made from the single heading in the 31-day period ending Apr. 9, 1940. This was an average of 60.6 ft. per day. Even more remarkable than the advance made in this selected period is the high daily footage maintained and which, though the face is 5 miles from the portal, is still being maintained. The job was started in July, 1939, and by September the average daily advance for any calendar month had not dropped below 45 ft., and since January of this year has been kept above 50 ft. As a matter of fact, the progress has not fallen below 40 ft. for any single day since last October and the maximum advance of 74 ft. was recorded on April 6.

The tunnel is being driven by the Golden Cycle Corp. to drain the deep workings of the world-famous gold mines of the Cripple Creek district, including the Portland, Ajax, Cresson, Vindicator and American Eagle, most of which are owned by the corporation. These mines all operate from shafts varying from 2,000 to 3,000 ft. deep; tops of shafts are all above El. 10,000. In 1907 the Roosevelt Tunnel was driven at El. 8,100, which successfully drained the area to that level. Since then, however, the workings have been deepened, requiring expensive pumping to keep them dry. At the start of the Carlton Tunnel driving last year pumping was discontinued and the deep workings were temporarily abandoned. Completion of the tunnel will not only permit resumption of mining in the lower levels, but is also expected to permit opening of new deep level areas. It will tap the mining zone at El. 7,000.

Usually fast tunnel driving results in excessive costs. Such is not the case, however, at Carlton. The Golden Cycle Corp. set aside $1,000,000 for driving the main 6-mile tunnel. Cost



Thos J. Barbre Photo

*Fig. 2. Simple and easily handled single-deck drill carriage, mounting five drifters, speeds up the drilling procedure.*

records to date, with the tunnel nearing completion, indicate that not only can the main tunnel be driven for that amount, but that some 9,000 ft. of laterals necessary to make the drainage fully effective can be driven under the original appropriation. And the whole job will be completed more than a year ahead of original schedule.

### Driving conditions dictated size

The size of the tunnel was dictated more by driving conditions than by permanent drainage requirements, for once the workings are drained, the flow will be small. A 10x11-ft. section with an arched roof was chosen as economical and an easy size to drive, and besides, the high roof will provide quite a factor of safety in case of an inrush of water when the water seams are tapped. The portal was located on the side of Oil Creek valley, about 10 miles south of Cripple Creek at a point where the main valley and side gulches offered plenty of room for muck disposal. An old county road from Cripple Creek and down a steep canyon had to be almost entirely rebuilt by the corporation for adequate access to the portal. An electric power line was brought in from Florence, 20 miles to the south, by a public utility company.

How the consistent high rate of progress is maintained day after day is explained by a time analysis of the complete cycle of operation. The cycle starts with the cleaning up of the last shovelful of muck. In 5 min. the mucker is moved out, and in another 5 min. the drill jumbo is moved in. Meanwhile the face has been painted for the new round and the track has been extended to the face with temporary rail units. The upper three of the five drills have been set up while the jumbo was rolling, the lower two take but a few seconds to swing into place, so drilling starts almost the instant the jumbo reaches the face, or only 10 min. after mucking is completed.

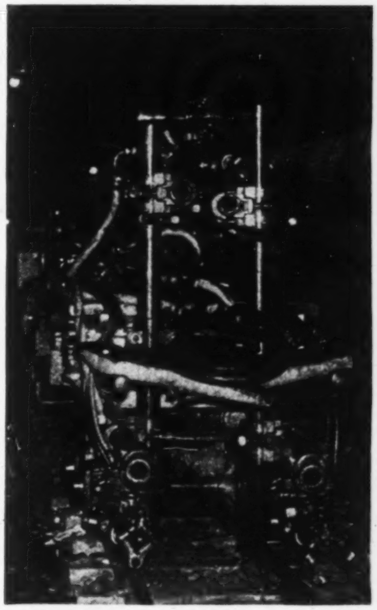


*Fig. 3. From a nearby side track the drill Jumbo is rolled into the heading, drills folded in for clearance.*

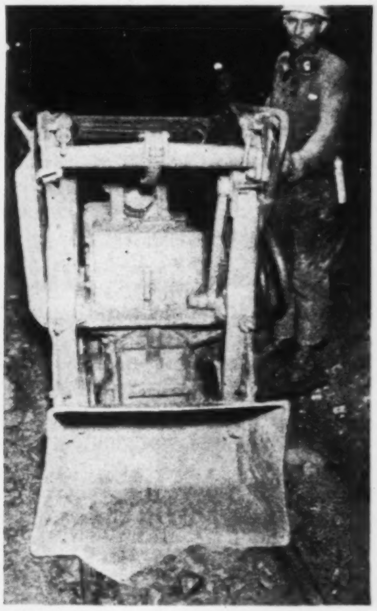
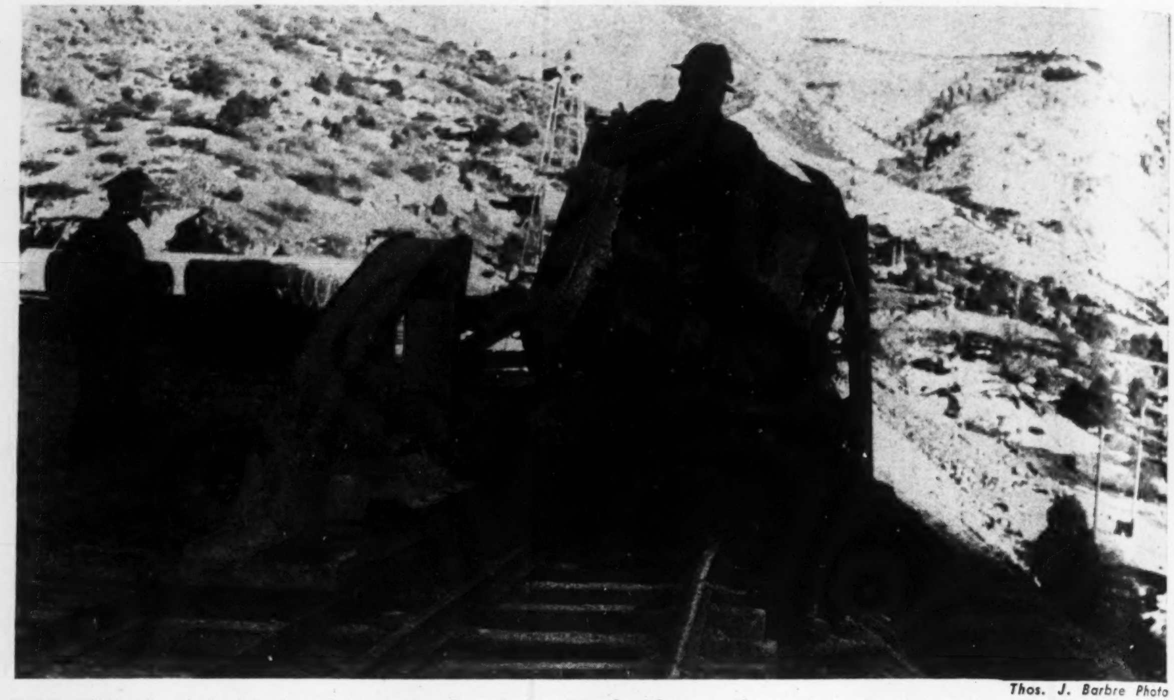


*Fig. 4. This air-operated mucking machine loads out a round of muck in about 1 hr., including moving in and out.*



Thos. J. Barbre Photo

**Fig. 5. Little time is lost in dumping a train of muck, for dumping dogs on the cars engage a portable ramp alongside the dump track and the cars tip over as the train moves past the ramp.**

The round is drilled out in 45 to 75 min., and another 12 to 15 min. is required for loading and shooting. During the next 10 min. the heading is gassed out and the mucker is brought to the face. Muck loading takes from 55 to 75 min. Then the cycle is repeated.

Operations go on like this with clockwork precision, with seldom a hitch. During the drilling a separate crew extends the permanent track, light and blasting circuits, and the vent pipe. Air and water lines are extended in brief moments while the mucker or jumbo moves out.

### Drilling and blasting

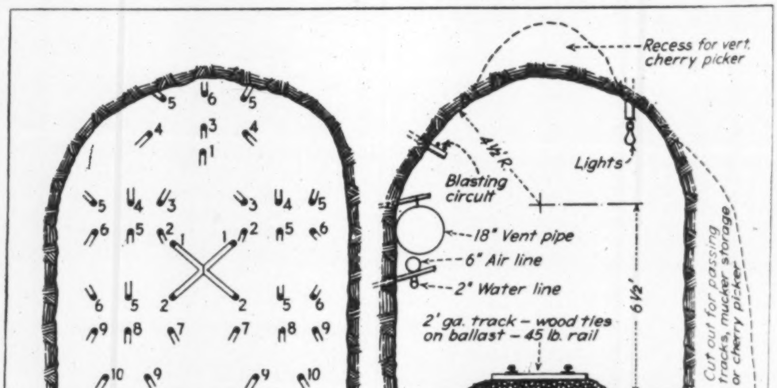
Drilling is done from a single-deck drill carriage, 20 ft. long, mounting five automatic-feed wet drifter drills on the front end. Much of the tunnel so far has been through a hard, flinty Pikes Peak granite that drills and breaks nicely, though stretches of dense, close-grained aplite are sometimes encountered. In the granite the typical drill round consists of 39 holes up to 9 ft. deep; in the softer aplite from 35 to 37 holes are drilled. A typical drill pattern is shown in Fig. 6. Mounted on the sides and rear of the drill jumbo are auxiliary bars and columns from which holes for pins and plugs are drilled with drifter and stopers to support pipelines, and light and blasting circuits. Also from these auxiliary positions are drilled the recesses in top and side of tunnel for the cherry picker, passing tracks, mucker and jumbo storage. All auxiliary drilling is done along with the drilling of the round so not a moment's time is lost.

When idle, the drill jumbo is parked on a sidetrack, if one is available, but more often in a niche in the side wall, into which it is shifted by two air hoists operating on transverse monorails.

Superintendent John Austin believes in plenty of power on the drills, so air is delivered to the jumbo at 125-lb. pressure, which means about 135 lb. at the compressors. Two compressors, of 1,800 and 1,000-ft. capacity, supply the air, though the smaller machine is idle most of the time.

### Detachable bits used

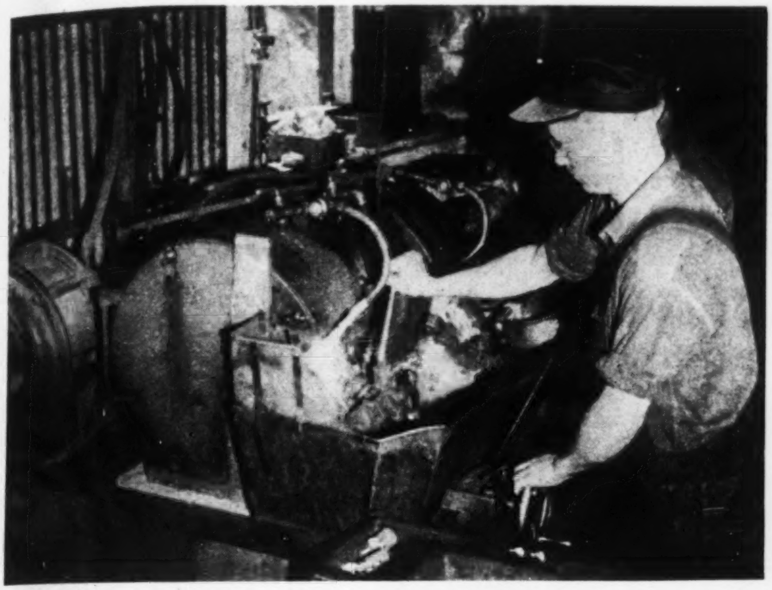
At first forged bits were used, but in October a change was made to detachable bits. After some experimenting a Sibley type bit was


5
6
5
4
3
4
1
5
4
3
3
4
5
6
5
2
1
1
2
5
6
6
5
2
2
5
6
9
8
7
7
8
9
10
9
9
10
Recess for vert. cherry picker
4½' R.
Lights
Blasting circuit
18" Vent pipe
6" Air line
2" Water line
6½'
2' ga. track – wood ties on ballast – 45 lb. rail
Cut out for passing tracks, mucker storage or cherry picker
10'
3½'

Typical Shooting Diagram
Numbers are delays

Typical Cross-Section
Showing utilities

**Fig. 6. Typical shooting diagram and arrangement of utilities. The track is well ballasted for high speed haulage.**



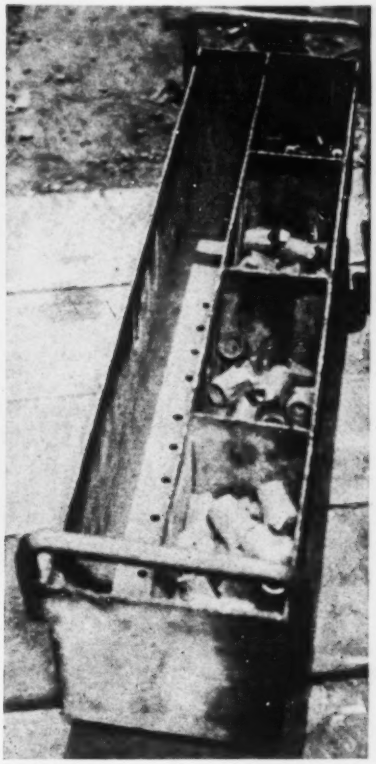


*Fig. 7. Two men and a grinder keep the detachable bits sharp. Often the bits stand six regrindings. At right, bit box, designed on the job, keeps the sharp bits properly sorted. Each drill runner is supplied with one of these boxes.*

adopted as best for the hard rock. Built for heavy service, the bit is $\frac{1}{8}$ in. longer and $\frac{1}{8}$ in. wider in the stock than standard bits. They are used with four lengths of $1\frac{1}{8}$-in. round steel, 3, 5, 7 and 9 ft., which have forged threads.

The detachable bits are resharpened by grinding at the job with remarkable success, for as many as six regrindings are obtained. New bits, used as starters, are $1\frac{3}{4}$ in. Loss of gage on the first grinding amounts to $\frac{1}{16}$ in.; on successive regrinds only $\frac{1}{32}$ in. is lost per resharpening. The sharpening procedure is to trim to gage first, then resharpen the bit. Two men on the grinding machine have resharpened as many as 1,261 bits in an 8-hr. shift.

Master mechanic Bob Welch devised a simple open-top steel box, divided into four square compartments to hold the bits for the four lengths of steel and one long compartment for dull bits. One of these boxes, numbered for identification, and containing a sufficient supply of bits to last a shift, is given each drill runner. Use of the boxes has not only simplified the handling of bits at the face, but has practically eliminated their loss, as each driller is held responsible for return of all bits.

Powder consumption has varied from 21 to 39.6 lb. per ft. of tunnel, or 5.1 to 9.6 lb. per cu. yd. (solid) excavation. A 60 per cent gelatin is used most of the time though both higher and lower strengths have been tried. Holes are well filled with powder, no stemming or plugs are used. The blasting hookup, with delays from No. 1 to No. 10, is a straight parallel circuit. Shots are fired by plugging the blasting line into the battery of a locomotive at least 1,000 ft. back of the face. The locomotive batteries carry 110 volts, sufficient to fire the round of 35 to 39 holes.

#### Mucking and hauling

From 14 to 17 three-cu. yd. muck cars are loaded per round by an air-operated mucking machine working from the temporary tracks. Loading and switching has averaged 4 min. per car throughout the job. An extra mucking machine is always kept in the tunnel close to the face as a spare so no time will be lost on account of repair or service delays. When not in use each of the two muckers is parked in a niche slabbed out of the side of the tunnel. They are shifted off the track by a transverse monorail air hoist. A third niche and hoist arrangement is used to hold the first empty muck car. While this car is being loaded, the remaining string of empties is pushed up to the mucker. A vertical air cherry picker, mounted on a frame straddling the track and equipped with an air hoist, changes the cars for muck loading. A recess about 2 ft. high above the normal arch roof is shot out at each cherry picker station to permit the empty car to be hoisted high enough to clear the loads.

In this long, single heading, getting longer each day, fast haulage is a necessity. Fast transportation here begins with an excellent track, 24-in. gage, on 3-ft. wood ties carefully ballasted. At the faces temporary 6-ft. units of rail and steel ties carry the drill jumbo and mucker. Rail joints in the main track are staggered to provide a smoother track, which requires a half-length rail at the heading end for connection to the temporary sections. A separate crew of eight men lays and maintains the track, and also takes care of all pipes and wiring.

Locomotives are 8-ton, 110-volt storage battery type, with extra large 56-cell batteries. They run 20 mph with a drag of 17 loaded muck cars down grade toward the portal, and 16 mph into the heading with the empties. Three locomotives took care of all hauling up to a heading length of 16,000 ft., then a fourth was added.

The 3-yd. muck cars dump to one side only. On the side opposite the discharge side they are equipped with a folding bracket or dog that normally fits into a recess in the side of the car. At the dump the dogs are pulled out by hand, and as the train

**PROGRESS AND DRIVING DATA—CARLTON TUNNEL**

| Month | Advance, ft. Per Month | Advance, ft. Cum. | Advance, ft. Daily Min. | Advance, ft. Daily Ave. | Advance, ft. Max. | Ave. No. of Rounds Daily | Ave. Length Round Ft. | Ave. Drilling Time Per ft. Minutes | Ave. Mucking Time Per ft. Minutes | Ave. Excav., per ft. Solid Cu.Yd. | Ave. Swell of Muck Per Cent | Powder, lb. Per ft. | Powder, lb. Per cu.yd. solid |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aug. | 1,201 | 1,546 | 26 | 38.7 | 53 | # | # | 18.6 | 18.4 | 4.1 | 42 | 21.0 | 5.1 |
| Sept.* | 1,367 | 2,913 | 35 | 48.8 | 61 | # | # | 15.8 | 13.6 | 4.2 | 41 | 23.5 | 5.6 |
| Oct | 1,534 | 4,447 | 40 | 47.2 | 57 | # | # | 16.1 | 12.9 | 4.2 | 40 | 24.7 | 5.9 |
| Nov | 1,474 | 5,921 | 43 | 49.1 | 56 | # | # | 17.1 | 12.2 | 3.9 | 31 | 30.2 | 7.7 |
| Dec.* | 1,387 | 7,308 | 44 | 47.8 | 56 | # | # | 17.4 | 12.7 | 4.4 | 35 | 33.2 | 7.6 |
| Jan | 1,438 | 8,746 | 40 | 46.4 | 56 | # | # | 18.1 | 12.9 | 4.4 | 31 | 36.6 | 8.3 |
| Feb. | 1,518 | 10,264 | 45 | 52.3 | 60 | # | # | 15.2 | 12.4 | 4.1 | 37 | 39.6 | 9.6 |
| Mar. | 1,735 | 11,999 | 44 | 56.0 | 68 | 7.2 | 7.8 | 14.7 | 11.1 | 4.0 | 39 | 38.6 | 9.6 |
| Apr. | 1,696 | 13,695 | 42 | 56.5 | 74 | 7.1 | 7.9 | 13.5 | 12.0 | 3.9 | 40 | 33.8 | 8.7 |
| May | 1,604 | 15,299 | 42 | 51.7 | 70 | 6.5 | 7.9 | 14.5 | 13.4 | 3.9 | 43 | 32.0 | 8.2 |
| June | 1,658 | 16,957 | 49 | 55.3 | 65 | 6.7 | 8.2 | 13.8 | 12.3 | 3.8 | 38 | 34.9 | 9.2 |
| July* | 1,396 | 18,353 | 47 | 53.7 | 64 | 6.7 | 8.1 | 12.5 | 12.5 | 3.9 | 36 | 40.8 | 10.4 |

* Holiday months. # Not recorded.

is pulled past the dumping spot, the dogs ride over a steel ramp that tips the cars. Two such ramps are used on different parts of the dump. They ride on and are pinned to a pair of angles fastened to occasional long ties. As the cars pass the dumping ramps, they automatically return to upright position.

### Ventilation and utilities

Ventilation of the long heading is a problem. At the portal is a 6,000-cfm fan connected to an 18-in. steel vent pipe. A 3,000-cfm fan inside the tunnel was used as a portable booster until the 16,000-ft. point was reached. Then another 6,000 cfm fan was placed in a permanent chamber cut into the sidewall. Ventilation is always by exhausting, as there isn't time to reverse the flow of air between shots.

The vent pipe is hung from steel dowells about spring line (Fig. 6). Directly beneath, carried on another set of dowels, is a 6-in. seamless steel tubing air line, welded into 90-ft. lengths and a 2-in. water line. Above the vent pipe is the blasting circuit; off center to the other side of the crown is the light circuit.

At first water for both domestic and industrial use was pumped from a nearby creek. About 3,000 ft. from the portal a couple of heavy flows of excellent quality water were struck. One of these was tapped by a pump for domestic and compressor shop use. A second pump was placed in a sump that catches the overflow from both seams, and supplies water to the drills.

### Organization

The Golden Cycle Corp., under the general supervision of Merrill E. Shoup, president, and A. H. Beebe, vice president in charge of mining, is doing the job direct. John R. Austin, superintendent, heads up an exceptionally small but efficient field supervisory force. One engineer, John G. Farmer, does all the engineering work and also acts as assistant superintendent. Robert W. Welch is master mechanic, but also acts as general foreman. One office man keeps the time, payroll and office records.

Work is carried on in three 8-hour shifts, seven days a week. A heading shift, in addition to the 8-man track crew, consists of one shifter, five drillers, four chuck tenders, one mucking machine operator, and two dinkey skinners. The drillers and helpers handle the cars during mucking operations. L. Stiles, A. Stiles and E. Gardiner are the shift bosses. All the supervisory force except Welch came to the job from the tunneling field.

A bonus system was set up on the basis of 10 ft. per shift or 30 ft. per day. Under the progress being made, the bonus, applying to supervisory and heading forces, amounts to about 50 per cent increase in the total compensation received.

## How to Reduce Filter Cloth Blinding

IN FILTERING SEWAGE SLUDGE on rotary drum vacuum filters the cloths used to retain the solids in the form of filter cake gradually become clogged or "blinded" until finally it becomes advisable to change to a new cloth. The service life of a filter cloth appears to be dependent upon a number of variables such as the nature of the sludge, the dosage and mixing of conditioning chemicals and the method of operating the filters.

To learn something of the nature of the material which caused the blinding the Minneapolis-Saint Paul Sanitary District operating staff made analyses of some of the short-lived cloths after their removal from the filters. It was found that lime in the form of calcium carbonate constituted from 85 to 93 per cent of the blinding material in these particular cloths, together with 3 to 8 per cent grease, 1.6 to 3.7 per cent iron as ferric hydroxide, and 1 to 5 per cent of acid insoluble material, mostly silica. The quantity of blinding material in grams per square foot of filter cloth ranged from 8 to 29. Examination of these cloths under the microscope revealed that many of the cloth fibers were heavily coated with a milky white material (lime carbonate) built up in icicle form.

It appears from the analyses that lime was the principal factor in the blinding of these particular cloths. While these cloths were in service, quicklime slaked as used was fed as a sludge conditioner to the extent of 5.9 to 8.4 per cent (CaO) of the dry sludge solids weight. The other conditioning chemical, ferric chloride, amounted to 1.9 to 2.5 per cent. The service life of the cloths tested ranged from 84 to 149 hr., contrasted with 170 hr. as the average life of all cloths during 1939.

These studies indicated that longer cloth life would result if the dosage of lime were held to a minimum.

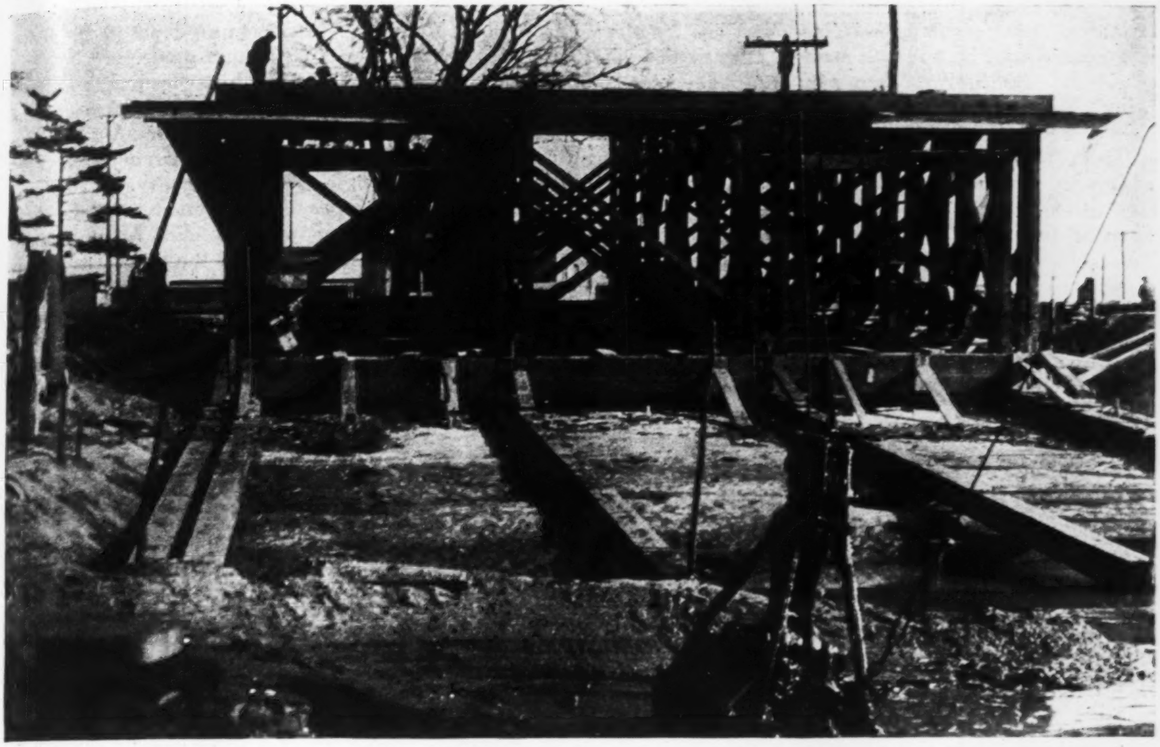


*Fig. 1. One of the three sections of cofferdam bracing for the Cooper River dam ready for launching.*

# Launched Bracing Cuts Cofferdam Costs

**John H. Osler, Jr.**

Engineer, Camden County Park Commission, Camden, N. J.

***Contents in Brief**—Cost reduction by shore-built cofferdam-bracing units launched and sunk end to end across river, with a single line of sheetpiling, plays an important part in building a dam to reclaim a foul swamp area for recreational and residential purposes.*

A COFFERDAM in which the bracing was launched and sunk in shore-built units was made tight with a single line of sheeting in 28 ft. of water in building the Cooper River dam near Camden, N. J. The method made possible a saving in construction cost of at least 50 per cent compared with other methods considered. Incidentally the dam, Fig. 3, is a vital part, as noted later, in a notable development of park and residential areas in Camden County.

The dam serves two purposes: (1) to hold polluted tide water out of the area being developed and (2) to keep a stationary pool level in the developed area. It is a concrete structure, about 194 ft. long over all, divided by three piers into two closed shore bays and two river bays in which are vertical gates. These piers rise from a base or sill as shown by Fig. 2 and carry a bridge across the dam.

### Foundations main problem

At the dam the river bottom is a black unconsolidated river mud containing a high percentage of organic matter; this mud varied east to west from 2 to 14 ft. in depth. Below the mud is a layer of fine sand, and below this coarse and medium sands and gravels. The concrete foundation was seated on a compact sand and gravel, slightly cemented and capable of sustaining many times the load to which it is subjected.

Under these conditions the size and depth of cofferdam for the 153 ft. 11 in. x 43 ft. 3 in. concrete dam base was such that under normal circumstances a cellular structure would have been used. However, to favor labor cost over material cost, a single line of sheetpiles supported by timber cribbing was adopted. The timber bracing was erected on temporary shipways and launched into the river. It was built in three sections, 52, 50 and 52 ft. long, 43¼ ft. wide and 16 ft. high, which were joined to form a bracing 154 ft. long.

The bottom members were 24x24 in., and top members 12x24 in., all made up of 12x12-in. timbers (see Fig. 5). Each unit weighed about 70 tons.

While the bracing cribs were being built, temporary guide piling was driven to support the cribs, and a 14-ft.-wide working platform was erected on each side, the full length of the cofferdam. The river bottom was then excavated to sufficient depth for launching and placing the cribbing. The launching procedure is indicated by Fig. 4, and Fig. 5 shows details of the service trestle and a unit of bracing.

After the bracing had been launched and the three units joined together it was weighted down into position and fastened to the temporary guide piling. The permanent sheetpiling was then set. As many piles as possible were set at one time, and driven down just sufficiently to stand. In this operation the outside members of the cribbing served as guides for the piledriving. The piling was then driven down to final depth (El-50). A No. 7B McKiernan-Terry hammer was used to start, and a No. 9B hammer for finishing. The entire driving operation was assisted by jetting, due to the highly compacted nature of the sand and gravel bottom. The deep-arch piling, weighing 27 lb. per sq. ft. of wall, and having a section modulus of 10.7 per lin. ft. of wall was used in lengths from 57 to 63 ft.

When the piling had been driven to full depth, El-50, the final excavation was carried out inside the cofferdam, in the wet, with clamshell buckets excavating between the bracing, which was supported by hangers from the steel sheetpiling. The cofferdam was pumped dry and excavated to full depth, in sand and gravel, by combined hand labor and machines. At this point the bottom of the bracing was about 8 ft. above the final bottom grade.

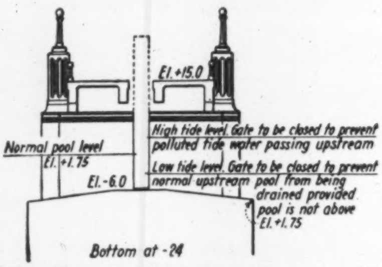

El.+15.0
High tide level. Gate to be closed to prevent polluted tide water passing upstream
Normal pool level
El. +1.75
Low tide level. Gate to be closed to prevent normal upstream pool from being drained provided pool is not above El.+1.75
El.-6.0
Bottom at -24

**Fig. 2. Piers rising from base, or sill, carry bridge floor and vertical gates that exclude tide water and retain pool level.**

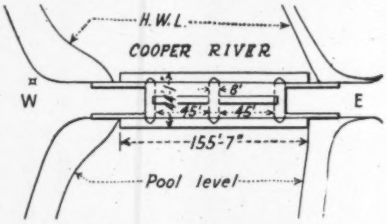

H.W.L.
COOPER RIVER
W
E
8'
45'
45'
155'-7"
Pool level

**Fig. 3. Essential structural elements of the Cooper River dam shown in outline plan.**

Open tile drains leading to a pump sump were laid around the inside perimeter of the cofferdam. A 4-in. and a 6-in. centrifugal pump were used to pump the dam dry. In the final stages of excavation only the 4-in. pump was required, running about 20 per cent of the time. The cofferdam was so tight that after unwatering very little pumping was required to keep it dry. In the final stages of excavation no boots or overshoes were worn by workmen, and the ground was firm enough to permit use of wheelbarrows without planks.

Pouring the concrete followed immediately. About 7 ft. of concrete was poured in two lifts, up to within 1 ft. of the bottom of the bracing. The lower tiers of the bracing were next dismantled, and temporary vertical struts placed to support the top tier. Concrete was then poured to finished sill elevation.

The steel sheetpiling was designed sufficiently strong to stand as a cantilever when braced at the bottom of the finished concrete sill. This permitted the removal of the top tier and gave an unobstructed area the full length of the cofferdam for working purposes.

Heavy reinforcing bars were fastened to clips which were welded to the sheetpiling to bond the piling to the concrete slab, making the piling

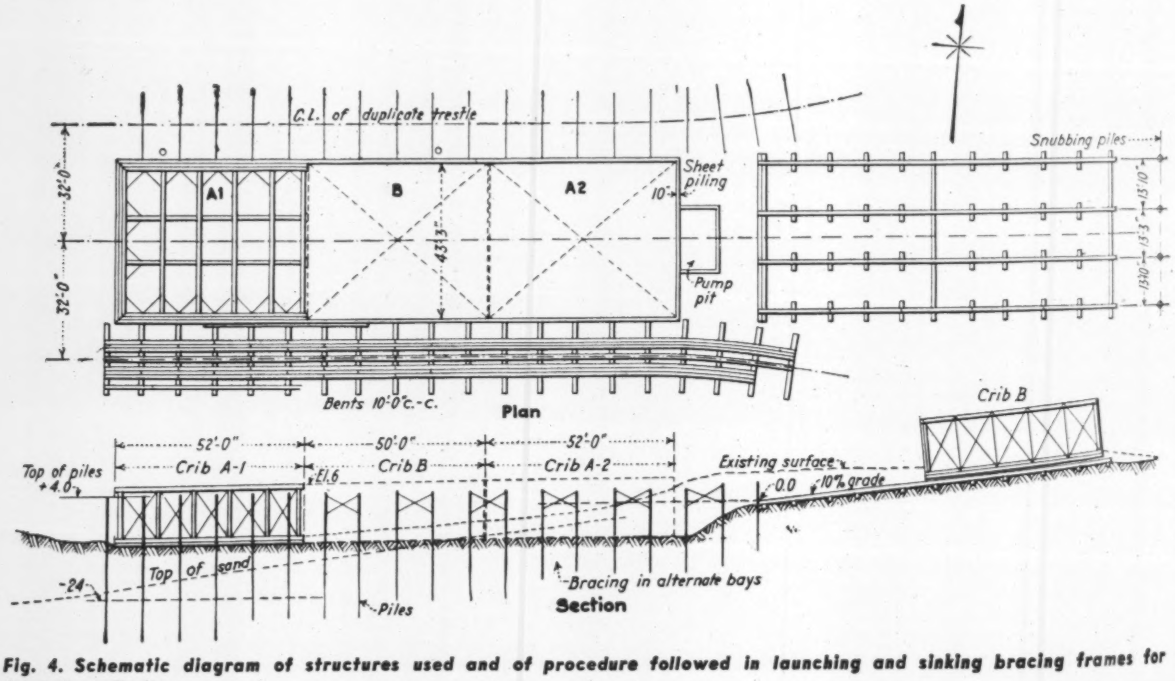

C.L. of duplicate trestle
32'-0"
32'-0"
A1
B
A2
43'3"
Sheet piling
10"
Pump pit
Snubbing piles
13'10"
13'-3"
13'-0"
Bents 10'-0"c.-c.
Plan
52'-0"
50'-0"
52'-0"
Top of piles +4.0
Crib A-1
El.6
Crib B
Crib A-2
Existing surface
0.0
10% grade
Crib B
Top of sand
-24
Piles
Bracing in alternate bays
Section

**Fig. 4. Schematic diagram of structures used and of procedure followed in launching and sinking bracing frames for sheetpile cofferdam.**

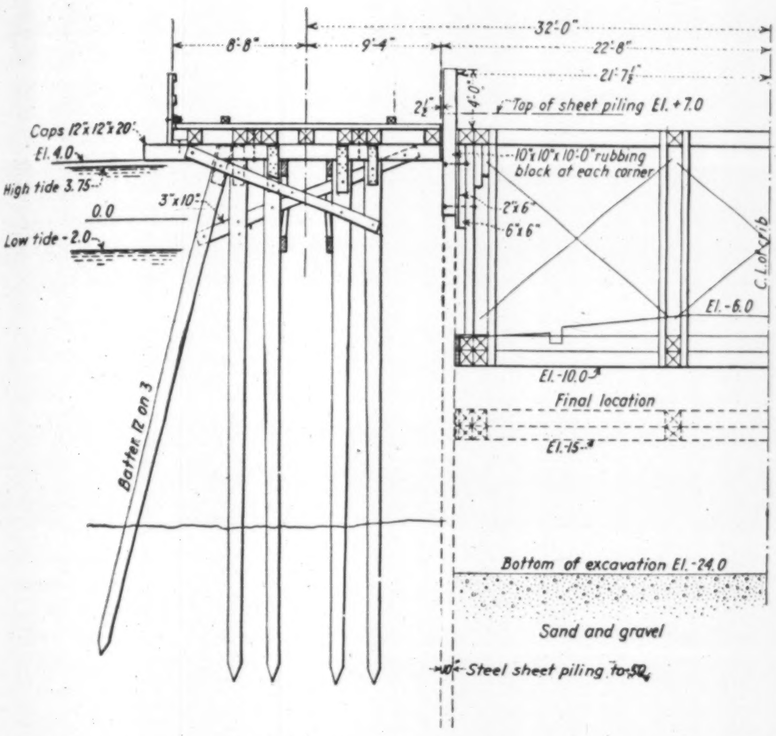


**Fig. 5. Half-section through crib and service trestles showing construction and tolerances for holding cribs to line and placing sheetpiles.**

a permanent and integral part of the structure. Reinforcing was placed in the main slab to distribute the load to the foundation and also to bond the piers to the main foundation block.

### Notable land improvement

Camden County, with a population of around 250,000, covers an area of 226 sq.mi. Of this, 4 sq.mi. represent water, mostly tidal streams, while about 15,000 acres constitute swampland. In addition, land totaling around 30,000 acres is considered undesirable for building development, due to proximity of swamps. In 1926 the Camden County Park Commission was established for the main purpose of reclaiming and improving swampland to make the county a better and healthier place in which to live. Included in this work are the developments on the Cooper River among which the new dam is an important part.

Formerly the Cooper River was hardly more than an open sewer. Tidewater backing up from the Delaware River, and the sewers of the city of Camden formed the main sources of pollution. To keep the polluted downstream water from entering the projected park area, to prevent flooding and eliminate mud flats along the shoreline at low tide it was decided to construct a dam which would insure a fairly constant water level in the river above the dam. The normal low tide at the place selected for the dam is —2.04 ft., referred to mean sea level, and the normal high tide is 3.56 ft., a difference of 5.6 ft. Yearly maximum low and high tides are —6 and 5.5 ft., respectively.

The design adopted for the dam includes vertical gates which will be closed when the tidewater elevation exceeds the normal pool level upstream. With the gates in their down position the elevation of the top is 9.0. The maximum all-time high tide on record is El. 8.88 ft.

The dam has two vertical lift gates with a span of 45 ft. each, about 15 ft. high and operated by electric motors with automatic control. Each gate weighs about 35 tons. An opening was built in the center of the bridge to permit the gates to operate. These gates will open automatically whenever the pool level above the dam exceeds the tidewater elevation downstream, provided the elevation upstream exceeds the normal elevation of 1.75 ft. Thus the floodwaters from the Cooper River will be passed without any substantial rise in the upstream pool level over what it would have been without any dam in place. Small tide gates in the main gates are capable of handling a dry weather flow without operating the main gates.

A lake about 5 miles long, with minimum width of 400 ft., uncontaminated by Delaware River water, will be created above the dam. This lake will meet all regulations for an 8-lane rowing course. A racing course will be an adjunct to this lake. The banks and the surrounding land are being beautified and landscaped, and paths and driveways, tennis courts, athletic fields, tracks, swimming pools and clubhouses are being constructed.

### Personnel

The entire project is under the supervision of the Camden County Park Commission, William H. Dunn, president. The work was performed by the Works Progress Administration under the direction of Robert W. Allan, state administrator and Fred S. Childs, chief engineer. The dam was designed by Joel D. Justin, consulting engineer, Philadelphia, Pa.

## Rail Failures Still Serious

Rails rolled in 1933 and under observation for five years had an average rate of 73.5 failures per 100 track miles during the period ending with 1938. This was shown by the records presented by the rail committee at the recent annual convention of the American Railway Engineering Association. This figure was an increase of 9.4 per cent over rate reported last year for rails rolled in 1932. However, the present rate for the 1934 rails is so low (25.4 failures per 100 miles for the four years) as to indicate that their final 5-year record will be appreciably better than for the 1933 rails. Early records have ranged as high as 398.1, 277.8 and 198.5 for 1908, 1909 and 1910, respectively. Since then there has been a general but not continuous improvement, with low rates of 60 and 64.1 failures per 100 miles for the rails of 1930 and 1932, respectively. Transverse-fissure failures totaled 16,137 in 1938, as against 17,787 in 1937. All these records include rails which break in the track and also defects classed as failures discovered by test or inspection before failure occurs.

# The Public Works Congress

***Each year the meeting of the American Public Works Association offers an opportunity for municipal engineers and officials to discuss current problems and exchange ideas in public works operation, organization and management. The convention at Detroit on Sept. 30-Oct. 2, laid emphasis on traffic control, parking meter experiences, pavement scaling, sewage treatment and byproduct use, cost keeping practice and national defense matters. The following extracts are from papers on these subjects. Details of the business session of the congress and the election of new officers were reported in ENR, Oct. 10, p 447.***

### CITIES AND NATIONAL DEFENSE

THE PRESENT National Council of Defense is established by legislation which was part of the preparedness drive in 1916. The Council, which is composed of six cabinet officials, adopted regulations last May which provided that its advisory commission be composed of advisors on industrial production, materials, employment, farm produce, price stabilization, transportation and consumer protection.

When problems arise which cut across all divisions, special sections or bureaus are established to meet the need of pooling resources. Of particular interest to public works officials is the newly created division of state and local cooperation.

With millions of dollars being spent on defense projects in shipbuilding and other industrial areas, city officials will be faced with administrative problems of unusual character. Construction of army cantonments will add to the difficulties. Overnight schools will possibly triple in enrollments, and many other public works will require extension. Public officials will be called upon to collaborate in a carefully supervised new housing development and, most important, they will have to make financial adjustment in taxing systems to prevent the administrative and financial difficulties which may arise after the emergency is over.—HUBERT R. GALLAGHER, *Assistant Director, Division of State and Local Cooperation of The Council of National Defense, Washington, D. C.*

### SEWAGE TREATMENT BYPRODUCTS

To reduce the cost of sewage treatment byproduct values can be obtained from both the gas and the sludge. More than 90 per cent of the sludge from the Dayton plant, for instance, is sold wholesale to fertilizer companies who use it as a conditioner and filler in the preparation of their mixed fertilizer; the average price for this material—ground, screened and sacked—is $6.50 a ton or $4.50 if sold in bulk f.o.b. carload lots. The retail price is about $20 per ton. These prices are high enough to pay the cost of processing the material if no drying fuel is required and no amortization charges are necessary to liquidate the cost of expensive drying, grinding, screening and bagging equipment.

***M. W. Tatlock tells how Dayton, Ohio, sells sewage sludge for fertilizer.***

The use of sewage gas for heating plant buildings, for heating the digesters, and for burning screenings has been common practice since collection was first attempted, but its general use in internal combustion engines is quite recent. Sewage gas may vary in volume from less than 0.50 to more than 1.50 cu. ft. per capita per day, with 0.80 cu. ft. as a reasonable average to be expected. The heat values range from a high of 700 to a low of 500 B.t.u. with an average of 600 B.t.u. being an accepted value for general use. The gas from a city of 100,000 population has a potential value of $17,000 per year if applied in the development of power.

What the future of gas utilization has in store for America may be indicated by reports from the war torn countries of Europe. Both Germany and England are reported to be compressing methane gas from sewage treatment plants into cylinders for use in motor trucks and buses; the General Italian Petroleum Company has a gas generating plant in Genoa for converting sewage and garbage into methane which will be piped into homes for cooking.—M. W. TATLOCK, *Superintendent of Sewage Treatment, Dayton, Ohio.*

*Discussion*—Milwaukee would not go into the production of fertilizer from sludge again, knowing now what we do about this business. Contrary to popular belief, we do not make a profit on sludge sales. Since January, 1927, we have been drying sludge, reinforcing it with chemicals and marketing it under the name of "Milorganite." The total cost per ton of Milorganite production has averaged $23.34. The net return has been only $14.96.

We can hardly consider we are making a profit, particularly in view of the fact that at the present time we must make a capital expenditure of about $300,000 for a new stack in order to control processing odors.—JAMES L. FEREBEE, *Chief Engineer, City Sewage Commission, Milwaukee, Wis.*

### DETROIT'S DISPOSAL PLANT

The Detroit sewage treatment plant—one of the largest in America—was dedicated July 1, 1940. The intercepters have a capacity of 2,000 sec.-ft. The plant, designed for a population of 2,600,000, contains grit chambers, trash racks, sedimentation and effluent chlorination facilities. One-eighth of the raw sludge is digested and elutriated, and the balance is conditioned with lime and ferric chloride. Sludge cake is incinerated. This plant serves Detroit and seven adjacent communities in Wayne County.

Operating data for the month of August, 1940, shows this plant treated an average of 285 mgd of sewage from which was removed grit amounting to 115.6 tons per day, wet rakings from the screens amounting to 22.9 tons per day, and 65 per cent sludge cake from the settling basins amounting to 564.5 tons per day including conditioning chemicals estimated at 11.1 per cent of the dry solids in the cake. The indicated efficiency of the sedimentation tanks operated with about three-hour detention period, is a removal of 61.8 per cent of suspended solids. The effluent chlorine demand for the month averaged about 6.5 ppm but ranged from a minimum of 1.8 ppm following a heavy rain, to a maximum of 28 ppm for a period of 2 hr. evidently due to a heavy dose of trade wastes in the sewage.

To these figures it is necessary to add about 14 ppm of chlorine to insure a residual in the effluent when it reaches the river. The plant uses on an average one 30-ton carload of chlorine in four days. A carload of chlorine costs $1,104 or about 5c. per capita per year.—C. W. HUBBELL, *Consulting Engineer, Detroit, Mich.*

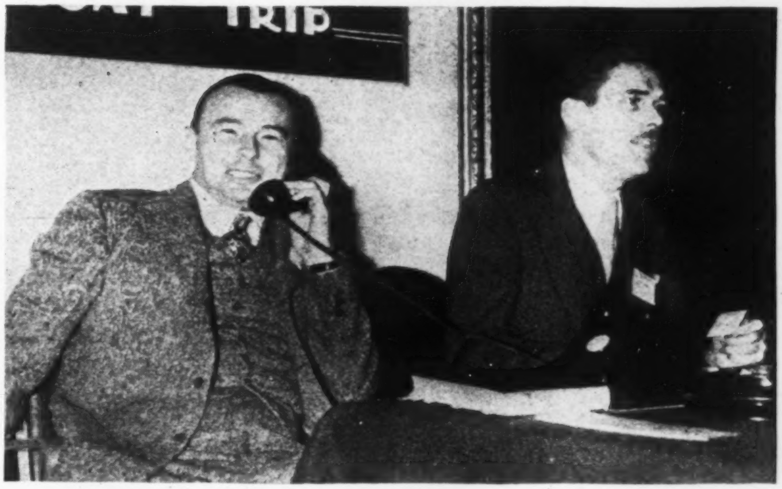
### BILLING FOR SEWAGE DISPOSAL

The problem of billing for sewage disposal on the sewer rental basis is not a problem but a series of problems. One of the questions that calls for consideration is selection of the most desirable rate structure.

Assuming that metered water consumption is to be the base, there are three sewage disposal rate structures to choose from:

(a) A uniform rate per thousand cubic ft. of water consumed;
(b) A stepped rate;
(c) A uniform per cent of the water bill.

Detroit adopted the uniform rate per 1,000 cu. ft. for the reason that the entire charge is for treatment and disposal of sewage that is picked up by the interceptors; consequently the cost of treating and disposing of any given unit of sewage is practically identical to the cost of treating and disposing in any other unit. There is, for example, no difference in the cost of treating and disposing of one million gallons of sewage contributed to the system by one large contributor, and the cost of treating and disposing of the same quantity contributed to the system by 1,000 contributors contributing 1,000 gal. each. The factors involved in a water rate study are entirely different in many respects. Certainly no one will contend that it does not cost more to deliver 1,000 cu. ft. of water to each of 1,000 customers than it does to deliver the total amount to one large customer.



**Clark M. Greene, general chairman and commissioner of public works, Dearborn, Mich., helps Norman Hebden, acting executive director of the APWA, to keep convention activities running smoothly.**

Another question deals with the selection of the most satisfactory means of forcing payment of sewage disposal charges. There are a number of possibilities, the principal of which are:

(a) The right of lien on the property
(b) The right to turn water off
(c) The right to disconnect the sewer
(d) Civil suit.

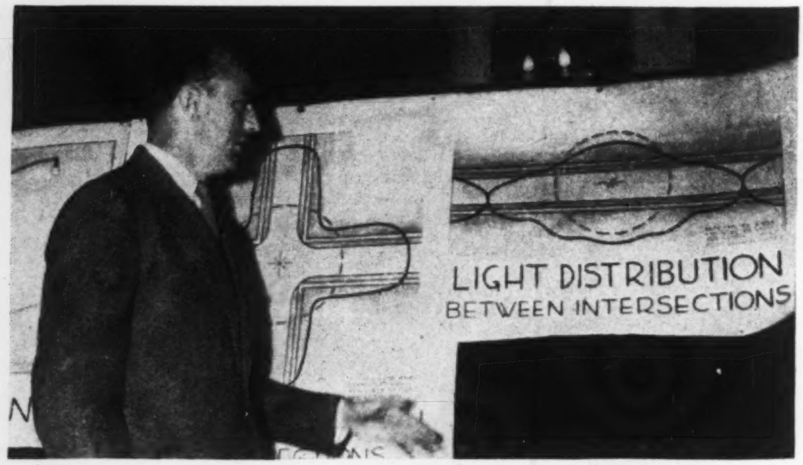
While the right of lien is a formidable weapon to use against delinquent customers, it is a most cumbersome and costly one, because of the expense of foreclosure which usually exceed to a considerable extent the ordinary disposal or water charge. Its principal value lies in the ability to fix responsibility and depends largely on some other agency to actually force collection. The perfect combination is the right of lien to establish liability and the right to disconnect sewer service and/or water service to the property for nonpayment of sewage disposal charge. The Detroit ordinance provides all of these measures and includes the "right to sue."—HAL F. SMITH, *Senior Administrative Assistant, Dept. of Water Supply, Detroit, Mich.*

### SCALING ON CONCRETE ROADS

Considerable research has been done recently with a view to developing a concrete pavement which will have greater resistance to scaling where severe freezing and thawing occurs and applications of calcium chloride and sodium chloride to icy pavements are thought necessary.

Studies by the Portland Cement Association show that applications of linseed oil or soy bean oil cut back with turpentine, naphtha or petroleum distillate, about 50 per cent for the first application and used straight or cut back up to 50 per cent for the second application, will protect the concrete against injurious effects of these salts. The first application is made at the rate of about 50 sq.yd. per gal., and the second application at about 65 to 70 sq. yd. per gal. The pavement should be in a reasonably dry condition at the time of application and the application should be made when the temperatures are above 50 deg. F. in order to insure penetration and rapid drying.

Experimental projects of concrete made from treated cement have been built in a number of states. These cements are normal portland cement



***Stuart M. Weaver explaining the new Montclair, N. J., lighting system.***

ground with addition of vinsol resin, beef tallow or other materials. The results of these tests (see *ENR*, Oct. 10, p. 471—Editor) show that concrete made from these cements has a high ability to resist scaling caused by freezing and thawing or damage from salt applied to icy pavements.

The use of sulphate-resistant portland cements in concrete mixtures, designed and placed at a stiff consistency to give a high density, and proper curing, will do much to improve the resistance of concrete pavement surfaces. The use of vibration in the construction of concrete pavement and bases is important in obtaining a dense pavement having higher resistance to surface scaling. In addition to the vibrators furnished in connection with the screeds and mechanical finishers other vibrators can be obtained which can be attached to finishing machines.—HENRY L. HOWE, *City Engineer, Rochester, N. Y.*

### REFUSE DISPOSAL COSTS

The primary use of records on refuse collection and disposal costs in Cincinnati is for administrative control, and the secondary objective is to provide statistical information. The Cincinnati system, therefore, is predominantly a yardstick for measuring efficiency. Items such as depreciation and interest on land and buildings and incinerators are excluded because they are in the nature of fixed charges and their inclusion would add nothing in measuring operating efficiency. The item of depreciation of motor equipment was included because it is a measure of proper operation of equipment. Items of maintenance of plant and replacement parts are also included because they reflect operating conditions.

The foundation of the entire system rests on the reports submitted by the field men. These are divided into two sections—one a report on personnel and the other on equipment used. The personnel report is also divided into two sections, one a payroll or time sheet, the other a cost breakdown sheet. Information from the field reports is submitted to the division of records where it is placed on tabulating cards. The monthly reports provide the following:

Statement of cost of collection of combustible and non-combustible material by routes and operation.

Hours and units of work performed by each piece of equipment operated by the division.

Summary report on collection. This gives expenditures and unit costs on the following: direct labor, equipment, set-out and set-back, overhead and total for both combustible and non-combustible collections, and cost of maintenance of dump and grounds.

Summary report of incineration. This gives for the three incinerators operated by the division expenditures and unit costs of charging-firing, removing ashes, plant maintenance and ground maintenance on each incinerator and a combined statement for the three.

Annual reports are provided which give a recapitulation of the monthly summary report. There is also an annual report on equipment operation showing maintenance, operation, depreciation and overhead cost of equipment. This includes a balance sheet showing the equipment earnings based on the charges used during the current year. This report is used as a basis for the ensuing year for determining rental rates for old equipment.—R. C. TAYLOR, *Superintendent of Waste Collection, Cincinnati, Ohio.*

### TRAFFIC CONGESTION PROBLEMS

Congestion on our urban streets comes from two sources. One of these is the growth of the cities themselves; the other is the shift to motor vehicles for individual transportation. City growth is largely unplanned and the adoption of the automobile has put the street system to a use for which it was not designed. The job of improvement and correction will be a long and costly one.

Undoubtedly the most important responsibility of today facing highway, civic and public works authorities generally, is the preparation of master plans for the modernization of our cities. It is not too much to say that the future of the metropolis—as an economic unit, as a solvent corporation, and as an organization for decent living—depends upon their success in meeting that responsibility.

In so far as the basic requirements for adequate motor vehicle transportation is involved in the future of the great city, every scrap of statistical evidence points in one general direction. The growth of city population, the growth of their industries and business, the increase in ownership and use of motor cars, and the increasing emphasis on outdoor recreation; all of these demand, as part of the solution to the traffic congestion problem, limited-access urban motorways which will carry their traffic swiftly, directly and safely to its multiple destination—MURRAY D. VAN WAGONER, *State Highway Commissioner, Lansing, Mich.*

### PARKING METER EXPERIENCES

Experience in Kansas City where parking meters were installed in 1936 has been that the meters are not a panacea, but they are a definite help in the distribution of adequate curb facilities. They aid in enforcement not only as to time limit regulations but by calling attention to illegal parkers. They permit a more accurate check of the time parked by each vehicle and by registering the exact time, they make the shopper more conscious of the need for rapid transaction of business, consequently increasing the parking turnover. They have forced the person who uses the curb for long time storage to move to side streets.

Revenue from parking meters in Kansas City ranges from $5 to $12 per meter per month, the average being about $8. Maintenance costs vary from 60c. to 85c. per meter per month.

Balanced against the benefits achieved in the use of parking meters are the following weaknesses:

It is impossible with meters to tell exactly whether or not a car is parked in excess of the time limit permitted.

They increase the number of vehicles parked at the curb in the area immediately surrounding business areas; in effect they increase taxation of motor vehicle operators, and they will serve no purpose without good enforcement to support them.

The benefits available as a result of meter parking (excepting revenue returns) can be obtained without meters, although it is a little more difficult to do so.—T. J. SEBURN, *Traffic Engineer, Kansas City, Mo.*

### KEEPING COSTS IN DETROIT

It is impossible to conduct a public works department without cost accounting system. Detroit is just now finishing the installation of a system which will give each division head a quick, accurate, and complete cost accounting of activity. On the surface that would seem to be all that is necessary, and it would be, if we could compare these costs with costs of other cities engaged in similar activity. However, this cannot easily be done. No two cities, due to various circumstances — topographical, geographical, custom, labor rates, methods of accounting, etc.—perform the same activity in the same fashion. Hence, we in Detroit will make cost comparisons within our own activity.

Where the activity allows us to separate the city into districts and the districts into sections, we will have the superintendent provided with a monthly statement, showing the cost of each activity in each section. When this report comes in, attention will immediately be called to the cost differences in the sections and explanations will be sought to account for them. Then, too, each section foreman and each district supervisor will see his costs posted on the board each month in comparison to the costs that the others have been able to make. Where an activity does not permit division into geographical limitations, our cost system will be divided either into units of work or activity, or, preferably, units of work per gang. Costs that cannot be compared are valueless.—W. M. WALKER, JR., *Commissioner of Public Works, Detroit, Mich.*

### TRUCK MANAGEMENT

Properly managed equipment assures performance resulting in the most satisfactory and efficient service at the lowest possible cost. The fundamentals of the management system used by the Baltimore bureau of street cleaning are these:

1. The proper type of equipment is purchased to fit the job to be done; there is a type of truck designed for every requirement.

2. All operators of equipment are experienced chauffers, regularly assigned to the same truck. Each chauffeur must have a general knowledge of motors, but no chauffeur is permitted to make repairs or adjustments. Needed repairs are reported on forms submitted to the shop superintendent.

3. Each piece of equipment receives regular attention by frequent inspections and greasing. This may be considered as preventive maintenance and is done by a small greasing unit operated by a mechanic and helper. This small truck is equipped with an auxiliary motor, air pressure tank and grease gun. In addition, some small parts are also carried. The mechanic not only greases the equipment, but checks the carburetor, distributor and generator, battery, horn, fan belt and brakes, and cleans, adjusts and replaces spark plugs.

***Morris Cohn, sanitary engineer and editor, goes into action.***

The repair shop is fully equipped and directed by a shop superintendent assisted by a staff of competent mechanics. Each mechanic is assisted by a helper who is expected eventually to qualify as a mechanic. These crews, comprising a mechanic and helper, change all tires and make minor repairs on the street. They handle all types of repairs in the shop except a complete overhaul job, which is usually done at the general repair shop of another city bureau.

Motor transportation reports for 1939 show that the hourly rate of truck operation is 81c., the mile rate is 16c., and the ton-mile rate is 12½c. Had the bureau hired all the equipment necessary to carry on operations, and not owned the 162 pieces of city equipment, an additional outlay of $125,000 would have been required.—GEORGE H. ELLIOTT, JR., *Associate Engineer, Bureau of Street Cleaning, Baltimore, Md.*

### BETTER STREET LIGHTING

A newly designed street lighting system will give Montclair, N. J., three times more effective lighting at no increase in cost. Principal features of the plan, which was prepared by a private consultant and is being carried out by the local utility company, are: utilization of fewer and larger lights; adoption of higher mounting heights; employment of light controlling devices (refractors); and adjustment of light intensities to traffic needs. (Details from this paper will be published in a forthcoming issue.)

Street intersections will be illuminated with a single light using a new four-way refractor. This not only brightly illuminates the intersection but each of the four beams will light at least 100 ft. of approaching streets.

Reflector-refractors will be used on all lights, thus making it possible to project 2½ times as much light on the street as is normally done with reflectors alone. Furthermore, light will be projected in an elongated elliptical pattern.—STUART M. WEAVER, *Executive Assistant to Commissioner of Public Works, Montclair, N. J.*

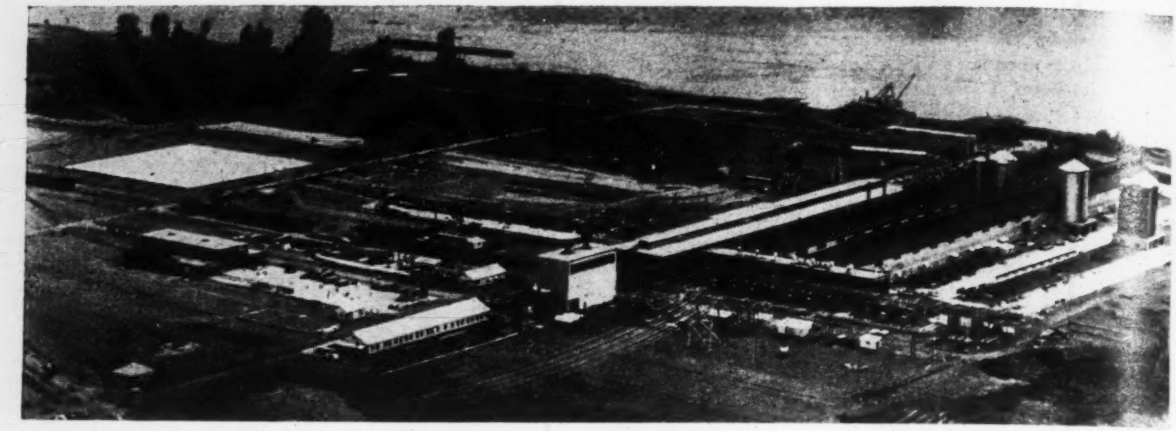


*Fig. 1. Where Northwest's first aluminum was produced six months after plant construction began.*

# Rush Job for Increased Aluminum Needs

**Contents in Brief**—*First plant to utilize hydro-electric power for producing aluminum in the northwest is located in Vancouver, Wash., where Bonneville power cost is $17.50 per kilowatt-year. By coordinated erection methods a plant with a capacity of 30,000,000 lb. of aluminum per year was completed in six months and, by the end of this year, another unit will go into operation to double this capacity.*

MANUFACTURING FACILITIES on a 50-acre tract of land on the north bank of the Columbia River two miles west of Vancouver, Wash., that had been a part of a dairy farm only six months before, on Sept. 23 produced the first metallic aluminum to be made on a large scale with hydro-electric power in the Pacific Northwest. The present installation occupies less than a quarter of the 215-acre area secured by the Aluminum Company of America at this location, but the first unit, just completed, will produce 30,000,000 lb. of aluminum per year, using alumina ore shipped by rail to Vancouver from the company's plant at Mobile, Ala. A second unit, planned and built as part of the national defense program, has a capacity equal to the first and will go into production before the end of this year. Back of this achievement is a rush construction job characterized by close scheduling, a large working force and carefully integrated operations. At times 800 men, representing 14 different crafts, were on the job at once.

When the company decided to expand its manufacturing facilities by the addition of a plant in the rapidly developing western territory, Vancouver was chosen as the location because of the low price offered on Bonneville power. Labor supply and climatic conditions are also favorable at the new location which, although more than 100 miles inland, is made accessible to seagoing vessels by the ship channel maintained at a depth of 35 ft. in the Columbia River.

The plant includes a dozen or more buildings ranging in area from the 40x80 ft. transformer station to the 230x635-ft. coke and carbon processing facilities. There are also four ore reduction buildings each 40x720 ft., a machine shop 90x420 ft., a carbon rodding building 80x504 ft. and a metal service building 75x450 ft.

The design of the various buildings follows functional lines. Structural steel frames are used throughout. Where temperature control is important, the buildings have brick sidewalls, aluminum sash, terra cotta book tile roof decks, and built-up waterproofing. In the main, however, the structures have corrugated aluminum sidewalls, aluminum sash and insulated steel roof decks with built-up waterproofing. Most of the floor areas are paved with brick on a concrete sub-base, although some floors are entirely of concrete.

### Rush construction program

The current demand for aluminum, which has been sharply accentuated by the national defense program, made the early completion of the plant desirable. As a result, the design of the various structures was rushed, and design and construction proceeded hand in hand. The construction schedule, aimed for the completion of the plant as soon as the operating power became available, was established early in the work and was used as a base whereby the designs were completed and the material purchased and delivered at the site at the correct time.

Construction began with the dredging of about 1,000,000 cu.yd. of soil from the shallow water of the Columbia River to provide a turning basin between the ship channel and the plant. By making this excavation first and discharging the spoil on the plant site, (average delivery distance about 800 ft.), ground surface of the entire 50-acre area was raised about 10 ft. This not only provided convenient disposal of the spoil that eventually would have to be taken out anyway, but also brought the floor level of the plant up above high stages of the river. One suction dredge, delivering through 30-in. discharge pipes, completed the dredging in about 30 days, starting March 9. The sandy nature of the spoil material facilitated both speedy drainage and surface grading. The latter was done with bulldozers and carrying scrapers.

The extent of the work and the area of the plant site made for excellent construction coordination. The foundations were installed as soon as the designs became available, and steel erection followed shortly after. Rapid completion of the buildings and installation of the equipment were aided by the practice of having the various materials and craftsmen available as soon as they could be used to advantage. Each craft followed the other as soon as possible. For example, on a particular day during the building of the 1,200-ft. conveyor bridge that carries the alumina to the point of storage, steel was being erected, riveted and painted, carpenters were installing flooring, millwrights were placing conveyor rollers, and corrugated aluminum roofing and siding were being attached. Groups of all five of these craftsmen were working on less than 500 ft. of the conveyor bridge at the same time.

### Power a major item

The original power contract for 32,500 kva was made late in December, 1939, and contemplated only one aluminum producing unit in conjunction with which was to be built a plant for the manufacture of carbon anodes. However, some several months after this announcement, plans were revised to provide for a second similar producing unit and hence the plant as built will require 65,000 kva. A substation on the Bonneville power transmission system adjacent to the plant delivers energy at 13,200 volts. The Aluminum Company's transformer installation steps this down to the voltages required in the various operations of the plant, the largest use being in the electrolytic cells for which the direct current required is obtained from a mercury arc rectifier plant built across the ends of the four ore reduction buildings.

The construction of the Vancouver plant has been under the supervision of officials of the Aluminum Company of America. Numerous contracts have been let, but the main portion of the work has been done by forces directly employed by the company. Officials in charge of the work have been Roy A. Hunt, president; T. D. Jolly, chief engineer and director of purchases; John W. Schreiber, chief construction engineer; B. C. McFadden, chief mechanical engineer; T. J. Bostwick, chief electrical engineer; V. C. Doerschuk, general superintendent, reduction division; R. O. Keefer, purchasing agent; C. S. Thayer, superintendent of operations, Vancouver works; and L. B. Kuhns, superintendent of construction.

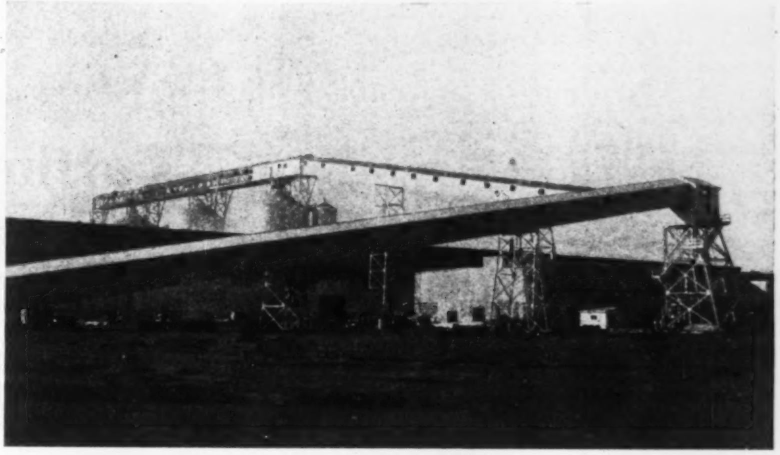


**Fig. 3. Corrugated aluminum siding incloses buildings and conveyors at Vancouver.**

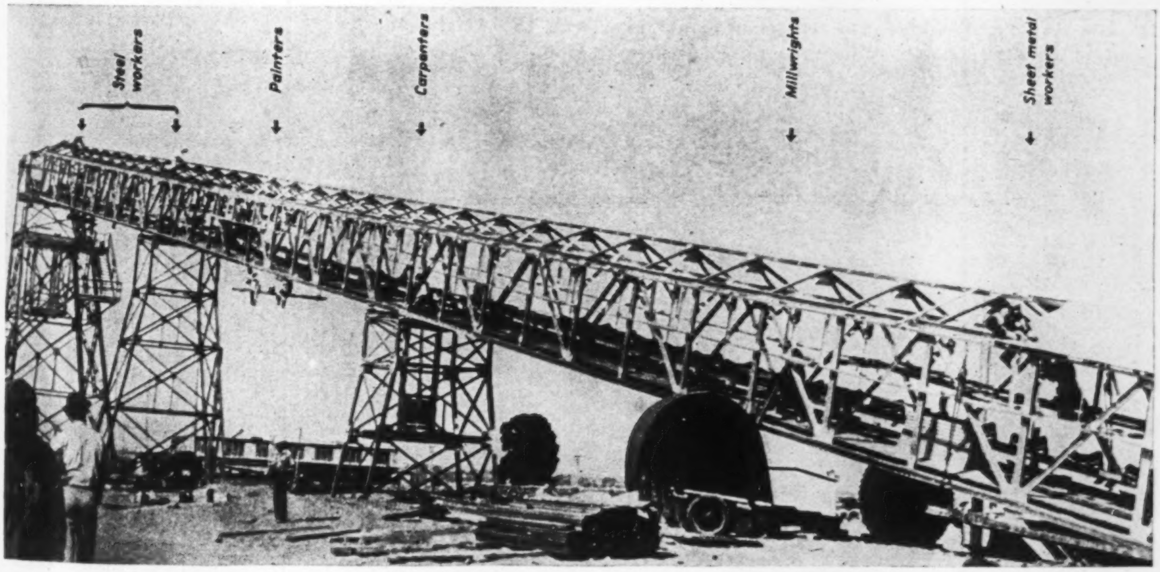


***Fig. 2. Indicative of the pressure to start aluminum flowing to defense industries is this view of five different crafts working on a 500-ft. length of a conveyor bridge that carries the alumina to the point of storage.***

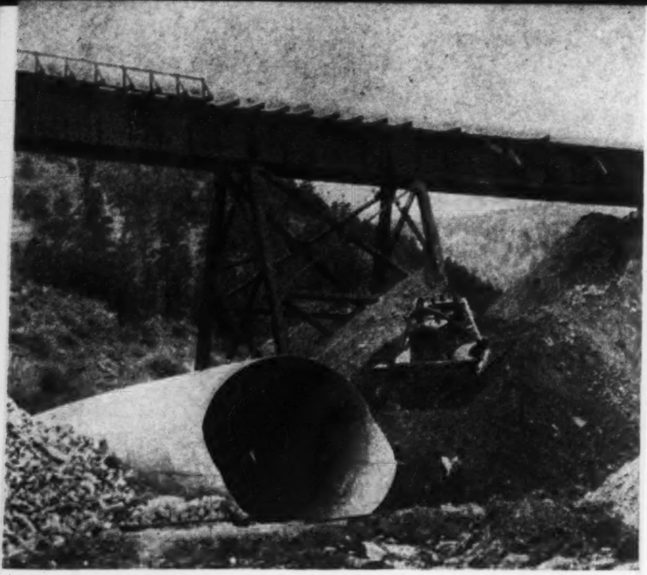


**Fig. 1. A bulldozer was used to push and tamp the fill in place around the 15-ft. variable-gage metal culvert.**

# Cutting Culvert Cost Under High Fills

**Contents in Brief**—*Considerable saving in cost of large culverts under high fills is being made by the Moffat Ry. in the use of variable-gage corrugated metal pipe. Instead of using one gage throughout, the road is now designing multiple-plate culverts with heavier gage plates at the center than at the ends where the fill load is light. A 15-ft. culvert, first of this design to be installed, shows no change in shape after a year in service.*

ENGINEERING OFFICIALS of the Denver and Salt Lake (Moffat) Ry. for years couldn't see why long corrugated metal pipe culverts under high fills had to be of one single weight or gage in view of the decreasing loads from the center toward each end. Consequently last year in the replacement of an old 256-ft. steel viaduct over Coal Creek, 23 miles west of Denver, with a 15-ft. multi-plate corrugated pipe culvert 165 ft. long, the pipe was designed to be built of four different gage plates. After nearly a year of train operation over the culvert, during which time careful checks were made on the behavior of the pipe, the departure from standard culvert practice has been regarded as so satisfactory that variable-gage plate culverts will be used on future installations at a considerable saving in cost. Possibly in some installations interior erosion might have serious effect on the light end plates, but it is planned to use a comparatively cheap bottom paving in such cases rather than go to heavier plates.

Elimination of the Coal Creek Viaduct is part of the general improvement program carried out by the Moffat Ry. for the past several years. (*ENR*, Sept. 2, 1937, p. 381). Conditions at the site called for a 15-ft.-diameter culvert and a fill 42 ft. high from top of culvert to subgrade (top of rail is 2 ft. above subgrade). Several standard designs of culverts were considered, including multi-plate pipe of all No. 1 gage plates, a double concrete box, a concrete arch and a concrete horseshoe section. Estimates of the cost were: multi-plate pipe, single gage, $10,525, including installation; concrete, $22,000 to $26,000. These designs were compared with one of multi-plate pipe with the weight of plates decreasing from No. 1 gage at the center, to No. 3, No. 5 and finally No. 7 gage plates at the ends. Cost estimates indicated the variable-gage design would be much cheaper, so it was adopted. Final cost figures showed the culvert cost $7,877 for material and $825 for installation, a total of $8,712, or a saving of more than $1,800 under the cheapest standard design.

### Gage determined by loading

Selection of the plate gages was guided by data from "Structural Design of Flexible Pipe Culverts" by M. G. Spangler, published in "Public Roads," Vol. 18, No. 12. The railroad engineers consider that the live load and impact on a fill is distributed downward from a 10-ft. base at subgrade through a wedge of $\frac{1}{2}$:1 slopes. Thus, for a 42-ft. cover, the live load is effective for a distance of about 52 ft., or 26 ft. each side of center of culvert. From the live-load zone to the ends of culvert dead load of fill only was considered. Calculations showed No. 3 gage ($\frac{1}{4}$-in.) plates were right on the border of selection for the live-load section. As a safety factor, No. 1 ($\frac{9}{32}$-in.) plates were specified for the three center sections of 10 ft. each, flanked by No. 3 plates for one 10-ft. section. For the next 10-ft. length, immediately outside the live load area, No. 5 gage ($\frac{7}{32}$-in.) plates were used, and for the remaining distance to each end No. 7 ($\frac{3}{16}$-in.) plates were considered ample. The arrangement of the different gage plates is shown in Fig. 3.

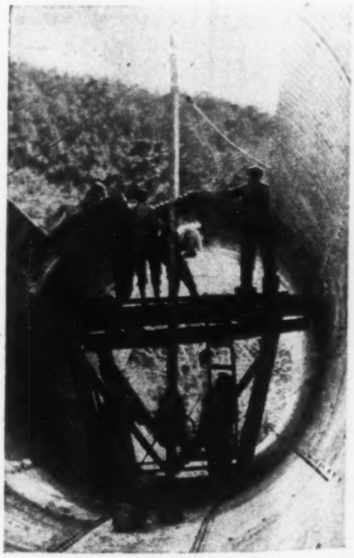


**Fig. 2. Plates were fabricated with the aid of a simple ginpole on skids, equipped with a hand winch.**

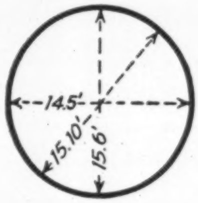
The plates are standard size, 6-in. pitch, 2-in. rise of corrugations, and 10 ft. long (parallel to axis of culvert). As a precaution against tearing of the metal, the usual number of 4 bolts per lin. ft. of longitudinal joint was doubled. Bolts were $1\frac{1}{16}$-in. of S.A.E. 1040 specification steel. Several 5-ft.-length plates were installed at the center of the culvert to provide a $2\frac{1}{2}$-ft. stagger of ring joints. This stagger approached a maximum effective use of each gage of metal.

### Simple erection scheme

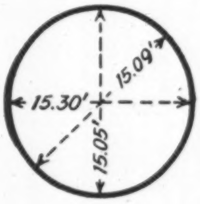
Advantage was taken of an abandoned road beneath the old trestle for a firm bed for the pipe. A shallow, curved bottom trench shaped to the lower quadrant of the culvert was excavated along the center of the road, but the pipe was completely fabricated above the trench on a series of cross struts of 12x12-in. timber. A portable ginpole, equipped with a hand hoist, was used in lifting the plates to place (Fig. 2). When complete the pipe was lifted by six jacks bearing against temporary straps bolted to the lower quadrant, the struts were pulled out, and the whole assembly was then lowered into the trench. The pipe was laid to a 6-in. camber at the center.

Before filling was started, the pipe was forced out of round, elongated 6 in. in the vertical diameter, by placing 33 vertical 8x10-in. struts bearing against top and bottom longitudinal sills, with 8x10-in. selected timber compression caps between struts and top sill. These struts were left in place for two months after the fill was completed.

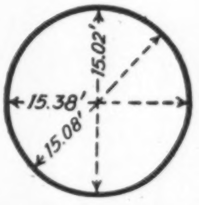
The 42,000-yd. fill was placed by dumping from railroad cars on the trestle. Backfill around the culvert was shoved into place in 1-ft. layers by a bulldozer, and compacted by repeated trips back and forth by the tractor. The effectiveness of the compaction is shown by the fact that when the fill was halfway up the pipe the sides squeezed in enough to lift the top of culvert 2 in. above the vertical struts. The culvert resumed the strutted shape when the cover reached about 5 ft.



Dimensions of Pipe When Struts Were Removed, Sept. 13, 1939



Pipe Dimensions, Dec. 6, 1939



Pipe Dimensions, Feb. 17, 1940
(No change since that date)

***Fig. 4. Built to an elongated vertical dimension, the culvert assumed a nearly circular shape three months after removal of the struts.***

Trenching began Apr. 15, 1939; the pipe was finished 10 days later. Filling reached top of culvert July 8, and was completed July 14. All fill material came from nearby alignment revision where a $16\frac{1}{2}$-deg. curve was reduced to 8 deg., and from cut widening and ditch cleaning operations.

### Pipe retains shape

The manner in which the culvert has retained its shape under the high fill is shown in Fig. 4. The top sketch shows the dimensions upon removal of the struts on Sept. 13. Three months later, the pipe had returned to almost a true circle, as shown in the center sketch. Another check on the dimensions made Feb. 17, 1940, recorded in the lower sketch, showed practically no change in shape, and subsequent checks have shown no variation from the Feb. 17 measurements.

The culverts were designed in the office of the chief engineer of the Denver & Salt Lake Ry. and installed by railroad forces under the direction of W. C. Jones, chief engineer, and Ed Sunergen, office engineer.

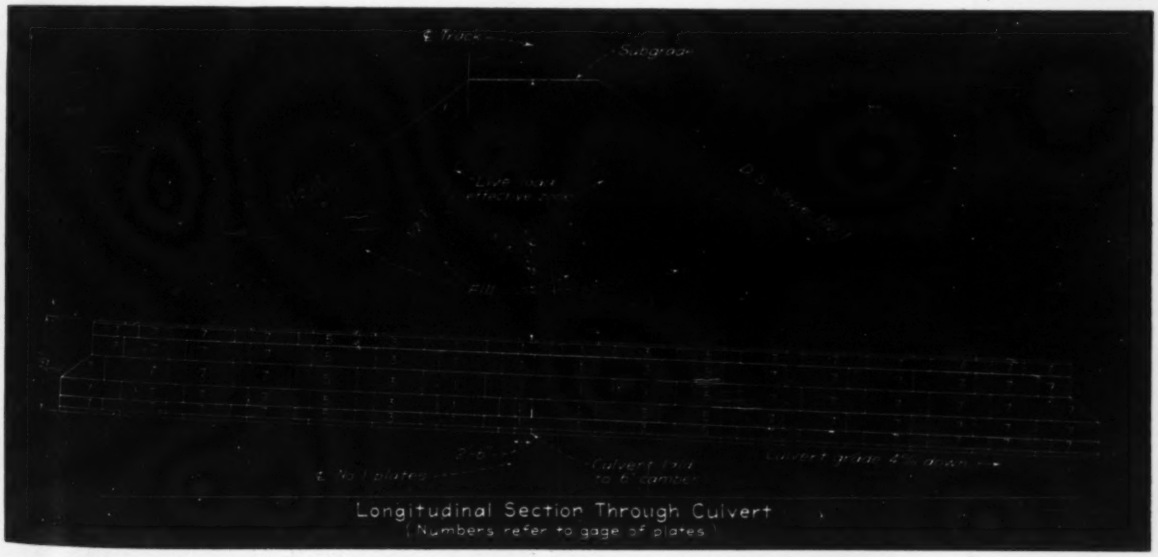

℄ Track
Subgrade
Live load effective zone
Fill
℄ No. 1 plates
2'-6"
Culvert laid to 6" camber
Culvert grade 4% down
Longitudinal Section Through Culvert
(Numbers refer to gage of plates)

***Fig. 3. Arrangement of the four different gage plates in the culvert. The two heaviest gages were considered necessary only under the effective live-load zone. Alternate 5-ft. plates in the center gave a 30-in. stagger to the ring joints.***

# From Field and Office

**Working problems and time-saving methods for engineers and contractors**

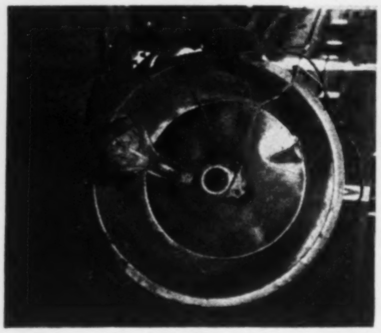
## Bridge Deck Renewal Method

To renew timber bridge decks with minimum traffic disturbance, the Oregon State Highway Commission leaves half the roadway width open to traffic while the other half is renewed. Deck planks are taken up for a part of the bridge length and immediately replaced by half-length planks, thus leaving the stringers exposed for half the roadway width while the other half is available for traffic. After work on the exposed stringers has been completed, the half-length deck planks are placed over them and the opposite stringers are laid bare. Finally the full-length planks are put back.

Much the same general plan is used where the planking is to be surfaced by 2x2-in. longitudinal strips; that is, half the bridge width is treated at a time. Where this is to be done the planks are spaced ¾ in. apart to afford ventilation which has been found to increase the deck life by retarding timber deterioration. An asphaltic mop coat is placed between planks and strips. The wearing surface put on top of the 2x2-in. strips is a ¾-in., non-skid oil macadam.

## Dishpan Reflectors

At Shasta Dam, dishpans with shiny tin-plate surfaces are used as reflectors for electric lights on every hand—mounted on poles, the sides of structures or wherever illumination for night work is needed. Inquiry brought the statement that they are purchased by the carload. The advantages are low cost, durability of the highly reflective surface, ease with which they can be restored to shape when dented or damaged, and convenience in quantity handling arising from the fact that they "nest."



*One of the many dishpans that reflect light for night shifts at Shasta Dam.*

## Celluloid Liner for Soil Sampling Cylinder

A celluloid liner for various types of soil sampling devices has been in use by the Missouri State Highway Department and has been found to be both simple and practical. The cylinder can be made to fit any diameter and length of soil sampling barrel and consists of a piece of transparent sheet celluloid rolled to the desired diameter and fastened at top and bottom with a convenient flat head paper clip.

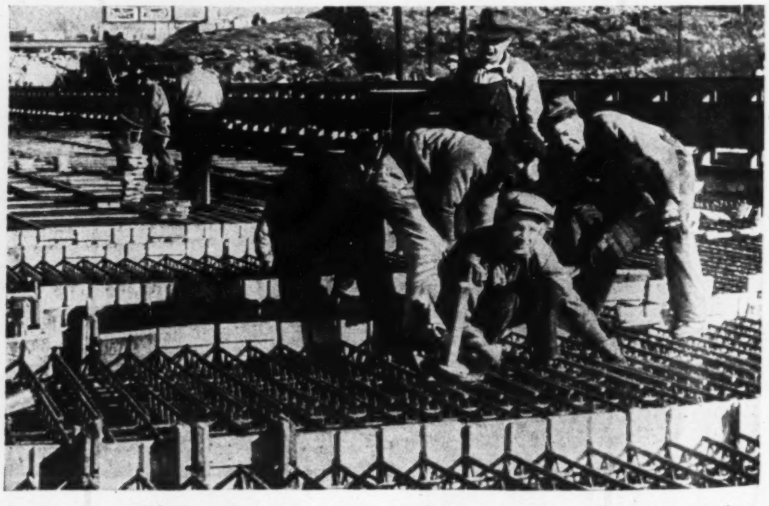
In forcing the soil sampler into the desired material the moist or wet soil specimen easily slides along the smooth surface of the celluloid with a minimum of friction. After retraction of the sampler the celluloid cylinder containing the soil sample is removed and sealed in a galvanized container for shipment to the laboratory.

The transparent liner permits an immediate examination of the soil sample to determine whether or not any change in stratum has occurred within the depth of penetration. The condition of the sample may also be examined and any foreign substance that would interfere with the representative qualities of the specimen can be readily observed.

After the soil sample has reached the laboratory and the liner containing the specimen has been removed from the sealed container, the soil is made ready for testing with a minimum of disturbance by simply removing the paper clip fasteners and unrolling the celluloid from around the soil specimen.—A. G. Copeland, *core drilling foreman, Missouri State Highway, Dept., Jefferson City, Mo.*

## Slotted Saddles Hold Truss Bars to Curvature

In placing the welded truss-bar reinforcing for the deck of the viaduct approach to the Lincoln Tunnel in Union City, N. J., the Duffy Construction Co. of New York bent the straight trusses to proper curvature on the deck to meet the varying curve of the roadway, and held the reinforcing in place by slotted wooden saddles, as shown in the illustration. The saddles, with slots equally spaced, were placed transversely across the roadway. The slots were open at the bottom to permit easy removal of the saddles as the concrete was poured for the slab. The contractor found this method much better than trying to prebend the truss bars to the desired curvature.



*Slotted saddles over which bridge floor reinforcement was bent to curvature.*

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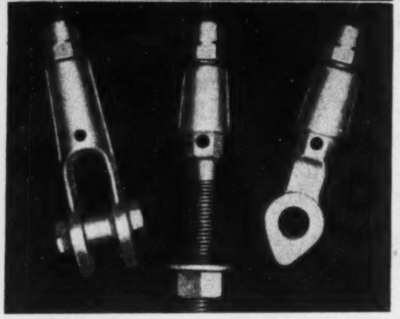

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# MEN AND JOBS

**Walter Smith**, engineer for the Mt. Vernon Steel & Bridge Co., is in Jacksonville, Fla. supervising the erection of steel by his company for the new St. Johns River Bridge.

**Frank A. Maloney**, draftsman in the surveys section of the U. S. Engineer Office at Huntington, W. Va., has resigned to accept an appointment in the Navy Department.

**Robert M. Crissman**, senior draftsman in the design section, U. S. Engineer Office, Huntington, W. Va., has resigned to accept private employment.

**Lenferd B. Zerkel**, engineer of James Stewart & Co., has left that organization to go into general contracting work in partnership with **Harry D. Mitchell**, also formerly with James Stewart & Co. The name of the new firm is Mitchell & Zerkel Co.; headquarters are at Chevy Chase, Md. Zerkel graduated in civil engineering from Tri-State College and was connected with the Bureau of Public Roads (now Public Roads Administration) for five years on the Skyline Drive and the Blue Ridge Parkway.

**W. R. Wallis** has resigned as a structural engineer for the New Mexico State Highway Department to join Allied Engineers, Los Angeles, Cal., a consulting firm.

**L. A. Rodenhiser**, formerly with the Work Projects Administration, has begun new duties as city engineer of Midland, Tex. Rodenhiser's first big job will be improvement of the municipal airport, next will be improvement of the Midland's water system.

**Benjamin F. Thomas, Jr.** is now associated with the Foundation Co., New York City, as chief electrical and mechanical engineer. For the past 7 years he has been with the Public Works Administration; previous to that had his own consulting offices in St. Louis, Mo.

**Capt. Le Roy Bartlett** and **Lieut. Irving M. Parry**, of the U. S. Engineers, have been ordered to Bolivia to study the military and economic feasability of constructing a railroad between Vila Vila and Santa Cruz.

**Dobb West**, engineer with the bridge department of the Colorado State Highway Department, has resigned to join the engineering department of the Consolidated Air Corp., in California.

**Wm. C. Borchert** has been named temporarily engineer of Pierce County, Wis., the post being vacant since the death of George Gilles.

**W. E. Sheddan**, city engineer of Jacksonville, Fla., was among those to receive a veteran's award from the American Public Works Association at that organization's recent convention in Detroit. Sheddan has been with the city since 1909.

**Carl Young**, a graduate of the University of North Carolina, has been named city manager of the town of Angier, N. C.

**Burton F. Miller** has been appointed executive assistant to **Charles M. Upham**, engineer-director of the American Road Builders Association. In his new work Miller will be in charge of the detailed operation of the Washington, D. C. offices in the absence of Upham. Miller has been with the A.R.B.A. since 1936. Formerly he was associated with the Construction League of the United States and directed the preparation of the construction codes under the NRA.

**Dillon Hemstreet**, formerly in private contracting work at Pearl River, N. Y., is now employed on fortification work in Porto Rico with the U. S. Engineers.

**J. S. Waldrep**, former city engineer of Oklahoma City, has been appointed construction engineer on the army cantonment work at Camp Beauregard in Louisiana.

**Ronald B. Decker**, former resident engineer inspector of the PWA for Oklahoma, has been appointed assistant engineer on the construction of the cantonment for the Army at Fort Sill, Okla.

**Franklin McArthur** of Guleph, Ont., has been appointed engineer for the township of Etobicoke, Ont. McArthur was formerly city engineer of Regina, Sask.

**Harry H. Mole**, civil engineer and state manager of the South Dakota Statewide Highway Planning Survey, has been called to active duty with the U. S. engineers and has been assigned assistant engineer of the 7th Corps Area with headquarters at Albany. Mole, who holds the rank of captain, was appointed city engineer at Kearney, Neb. in 1922, a position he held until 1927 when he became supervising engineer for the

(*Continued on p. 90*)

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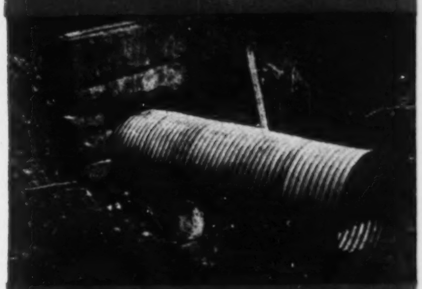

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# CONTRACT UNIT PRICES

**What contractors are bidding on different kinds of construction work**

## DUCHESNE TUNNEL UTAH

**OWNER:** Bureau of Reclamation, Provo, Utah. E. O. Larson, construction engineer.

**PROJECT:** Excavation of downstream half of 6-mile Duchesne Tunnel about 24 miles east of Heber, Utah. Tunnel 15,840 ft. long; 10-ft. 7-in. diameter; modified horseshoe section. Involves approximately 34,000 cu. yd. of open cut excavation and 54,000 cu. yd. of tunnel excavation. (Spec. No. 926.)

**CONDITIONS:** Government to furnish cement, and grout pipe and fittings; balance of material to be provided by contractor. Rail and highway facilities available to Heber, about 24 miles from site of work. Work to be completed in 900 calendar days. Minimum wages are: skilled labor, $1.10 to $1.25 per hr.; and common labor, 65c. per hr.

**BIDS:** Eight bids were received August 21, 1940, ranging from the contract low of $727,575 to $1,338,250.

**LIST OF BIDDERS:**

| | |
|---|---|
| 1. Utah Construction Co., Ogden, Utah (contract) | $727,575 |
| 2. Lowdermilk Bros., Denver, Colo | 851,350 |
| 3. Gordon Constr. Co., Denver, Colo | 923,970 |
| 4. Arundel Corp. and L. E. Dixon, Los Angeles, Calif | 973,225 |
| 5. R. A. Bell, A. Teichert & Hanrahan, San Marino and Sacramento, Calif | 994,185 |
| 6. W. W. Clyde & Co., Springville, Utah | 1,000,260 |
| 7. Thompson-Markham Co., Los Angeles, Calif | 1,028,250 |
| 8. United Concrete Pipe Corp., Los Angeles, Calif | 1,338,250 |

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Common excavation, open cut | 27,000 c. y. | $0.25 | $1.45 | $0.30 |
| 2. Rock excavation, open cut | 7,000 c. y. | 1.00 | 1.45 | 1.00 |
| 3. Excavation, all classes, tunnel | 54,000 c. y. | 11.75 | 13.25 | 15.35 |
| 4. Perm. steel tunnel supports | 480,000 lb. | .07 | .07 | .08 |
| 5. Permanent tunnel timbering | 325 M bm. | 80.00 | 90.00 | 60.00 |
| 6. Steel tunnel liner plates | 90,000 lb. | .075 | .07 | .08 |
| 7. Washed gravel or spalls | 125 c. y. | 8.00 | 15.00 | 3.00 |
| 8. Drill grout holes, 10 ft | 1,000 l. f. | 1.00 | 2.00 | 1.00 |
| 9. Place grout pipe and connections | 500 lb. | .50 | .50 | .50 |
| 10. Pressure grouting | 2,000 c. f. | 1.25 | 2.00 | 1.25 |

## HIGHWAYS, SOUTH DAKOTA

**OWNER:** Public Roads Administration, District 3, Denver, Colo.; B. W. Matteson, district engineer.

**PROJECT:** Improvement of 0.682 miles of graded and drained earth highway and structures in Harney National Forest in Pennington County, S. Dak., on Deadwood-Custer-Hot Springs Route. Highway width 28 ft.

**CONDITIONS:** Contractor to furnish all materials and complete work in 120 calendar days. Rail and highway transportation facilities available. Wage rates specified are: skilled labor, 70c. to $1.00 per hr.; semi-skilled, 55 to 60c.; and common labor, 45c. per hr.

**BIDS:** Six bids were opened September 27, 1940, ranging from the contract low of $62,717 to $82,993. Engineer's estimate $80,338.

**LIST OF BIDDERS:**

| | |
|---|---|
| 1. Western Contracting Corp., Sioux City, Iowa (contract) | $62,717 |
| 2. Peter Kiewit & Sons Co., Omaha, Neb | 73,750 |
| 3. Northwestern Engr. Co., Rapid City, S. Dak | 74,000 |
| 4. Inland Construction Co., Omaha, Neb | 80,240 |
| 5. Chaulk & Birdsall, Rapid City, S. Dak | 81,735 |
| 6. Lowdermilk Bros., Denver, Colo | 82,993 |

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Clearing | 7.5 ac. | $100.00 | $100.00 | $100.00 |
| 2. Grubbing | 1.5 ac. | 150.00 | 100.00 | 100.00 |
| 3. Unclassified excavation | 99,000 c. y. | .545 | .65 | .55 |
| 4. Unclassified excav., struct | 110 c. y. | 2.00 | 1.00 | 1.25 |
| 5. Special overhaul | 160,000 sta. y. | .01 | .01 | .015 |
| 6. Special overhaul | 2,000 c.y. mi. | .10 | .10 | .15 |
| 7. Finishing earth graded roads | .887 mi. | 500.00 | 1,000.00 | 300.00 |
| 8. Untr. timber, incl. bridge iron | 4 M bm. | 100.00 | 50.00 | 145.50 |
| 9. Cl. A cement stone masonry | 12 c. y. | 15.00 | 30.00 | 18.00 |
| 10. 24-in. corr. galv. sheet metal pipe, 14-ga | 242 l. f. | 2.50 | 4.00 | 2.45 |
| 11. 36-in. corr. galv. sheet metal pipe, 12-ga | 80 l. f. | 3.50 | 5.00 | 5.05 |
| 12. 36-in. corr. galv. sheet metal pipe, 10-ga | 214 l. f. | 4.00 | 5.50 | 6.00 |
| 13. 48-in. corr. galv. sh. met. pipe, 8-ga. | 156 l. f. | 9.50 | 10.00 | 10.85 |
| 14. Log cribbing | 1,000 s. f. | 1.20 | .75 | .475 |
| 15. Laminated or strip floor | 3.2 M bm. | 100.00 | 90.00 | 124.97 |

## BRIDGE, CALIFORNIA

**OWNER:** California State Highway Department, Sacramento, Calif.; C. H. Purcell, state highway engineer.

**PROJECT:** Construction of a steel truss swing bridge, nineteen steel beam approach spans over Mokelumne River, five miles west of Terminous, and a timber stringer ramp trestle at the west approach to Little Potato Slough crossing, all in San Joaquin and Sacramento Counties, Calif.

**CONDITIONS:** Rail, highway and water transportation facilities available. Contractor to furnish all materials and complete work in 350 working days. Conditions at site require expensive foundations, and contract calls for long concrete piles. Assistant bridge engineer states that bid prices were undoubtedly affected by the uncertainty as to supply of skilled labor and delivery date of materials. Prevailing wages on project are: skilled labor, 90c. to $1.60; semi-skilled labor, 85c. to $1.00; and unskilled labor, 69 to 75c. per hr.

**BIDS:** Three bids were received October 2, 1940, ranging from the contract low of $467,732 to $711,381.

**LIST OF BIDDERS:**

| | |
|---|---|
| 1. United Concrete Pipe Corp., Los Angeles, Calif | $467,732 |
| 2. A. Soda & Son, Oakland, Calif | 499,788 |
| 3. Pacific Bridge Co., San Francisco, Calif | 711,381 |

| Item | Quan. | Unit Prices (1) | (2) | (3) |
|---|---|---|---|---|
| 1. Remove existing piles | L.S. | $2,000.00 | $2,500.00 | $415.00 |
| 2. Clear and grub | L.S. | 2,000.00 | 3,500.00 | 1,100.00 |
| 3. Struct. excavation, type A | 950 c. y. | 21.00 | 20.00 | 3.00 |
| 4. Struct. excavation, type B | 410 c. y. | 10.00 | 3.00 | 9.00 |
| 5. Reinforcing steel bars (furn.) | 287,000 lb. | .035 | .04 | .06 |
| 6. Place reinf. steel bars | 287,000 lb. | .015 | .01 | .02 |
| 7. Mesh reinforcement | 1,000 s. y. | .50 | .50 | .72 |
| 8. Cl. A Portland cem. conc. (footing bl.) | 520 c. y. | 20.00 | 10.00 | 18.00 |
| 9. Cl. A Portland cem. conc. (structure) | 1,738 c. y. | 25.00 | 26.00 | 45.00 |
| 10. Lightweight Port. cem. conc. | 205 c. y. | 30.00 | 30.00 | 55.00 |
| 11. Furnish structural steel | 1,892,000 lb. | .07 | .075 | .13 |
| 12. Erect structural steel | 1,892,000 lb. | .02 | .0225 | .035 |
| 13. Misc. iron and steel | 1,750 lb. | .15 | .30 | .40 |
| 14. Untr. Douglas Fir timber | 6 M bm. | 100.00 | 65.00 | 150.00 |
| 15. Treated Douglas Fir timber | 100 M bm. | 150.00 | 125.00 | 273.00 |
| 16. Solid timber railing | 3,054 l. f. | 2.00 | 1.80 | 4.50 |
| 17. Untr. Douglas Fir test piles and piles | 7,480 l. f. | .30 | .35 | .30 |
| 18. Driving above piles | 147 ea. | 20.00 | 90.00 | 44.00 |
| 19. Tr. Doug. Fir piles, incl. test piles | 29,620 l. f. | .80 | .80 | .55 |
| 20. Driving above piles | 478 ea. | 25.00 | 30.00 | 44.00 |
| 21. Furn. 22-in. sq. precast conc. piles incl. test piles | 3,325 l. f. | 3.00 | 3.00 | 4.00 |
| 22. As above, 24-in. sq | 5,430 l. f. | 3.80 | 4.00 | 4.50 |
| 23. Drive precast conc. piles, incl. test piles | 112 ea. | 200.00 | 200.00 | 105.00 |
| 24. Pipe handrail | 130 l. f. | 2.50 | 5.00 | 6.50 |
| 25. Remove existing guard railing | L.S. | 1,000.00 | 250.00 | 250.00 |
| 26. Plywood | 2,930 s. f. | .10 | .10 | .40 |
| 27. Gravel backfill | 125 c. y. | 3.00 | 4.00 | 4.00 |
| 28. Permanent signs | L.S. | 500.00 | 1,000.00 | 500.00 |
| 29. Control house | L.S. | 1,000.00 | 3,000.00 | 2,660.00 |
| 30. Electrical equipment | L.S. | 20,000.00 | 20,000.00 | 35,000.00 |
| 31. Mechanical units | L.S. | 10,000.00 | 8,500.00 | 11,600.00 |
| 32. Machinery | 88,500 lb. | .50 | .60 | .75 |
| 33. Misc. items of work | L.S. | 1,000.00 | 3,516.64 | 2,660.00 |

## NEW FACTORIES AND PLANT ADDITIONS IN USE WEEKS SOONER

# SPEED DEFENSE CONSTRUCTION

### *'INCOR' 24-HOUR CEMENT PREVENTS WINTER SLOW-DOWN, CUTS COLD-WEATHER CONSTRUCTION COSTS*

IT'S full speed ahead in defense construction. Hundreds of important projects like the new addition to United Aircraft Corporation factory (above), at East Hartford, Conn.—built with Lone Star Cement by Turner Construction Company, New York, general contractor; Albert Kahn Associates, Detroit, architects and engineers—are being pushed to completion, day and night, without a let-up.

**WINTER PREPAREDNESS**

But winter is just ahead—and now is the time to safeguard against the usual cold-weather slow-down. Defense construction cannot wait on the thermometer. Fortunately, it doesn't have to—'Incor' 24-Hour Cement makes possible normal job speed, even in dead of winter with its sub-freezing temperatures. By hardening thoroughly in one-third the usual time, this improved Portland cement minimizes freezing risk, cuts heat-protection costs by 50 to 60 percent, saves two to five days' delay on each pour.

**'INCOR' SAVES VITAL WEEKS**

These 'Incor' time savings add up to weeks—weeks that are vital in defense construction.

Make every day count this winter—speed completion of new factories and plant additions, highways and bridges, air and naval bases—use 'Incor'* 24-Hour Cement for top-speed construction at rock-bottom cost.

Write for copy of illustrated book, "Cold-Weather Concreting." Lone Star Cement Corporation, Room 2281, 342 Madison Avenue, New York. *Reg. U. S. Pat. Off.

**LONE STAR CEMENT CORPORATION**

**MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT**

# MATERIALS AND LABOR PRICES

***Market quotations on construction materials and wage rates reported monthly by ENR correspondents***

LUMBER price increases continue to provide the most important change in the construction material list. The higher prices for lumber have brought about gains in both railroad tie and plywood quotations. Short Leaf Yellow Pine is up $1.50 to $2.00 in Atlanta and Cleveland; $2.00 to $2.50 in Baltimore; $5.00 to $8.50 on 1- and 2-in. sizes in Birmingham; $5.00 to $8.00 in Chicago; $2.00 to $4.00 in Dallas, New York and Detroit; and $3.50 to $5.50 in Kansas City.

Douglas Fir is $2.00 higher in Baltimore; up $1.00 to $2.00 in Chicago; up $3.00 to $5.25 in Kansas City; up $3.00 to $4.00 in Los Angeles; up $1.00 to $3.50 in Minneapolis; up $4.00 to $7.50 in San Francisco; and $2.00 to $3.00 higher in Seattle.

Seattle base price for form grade plywood increased on the average of about $5.00 per M ft. for all sizes, but many mills are still out of the market due to the rush of defense orders.

Cement prices are 17c. per bbl. higher in Dallas, and up 30c. in Detroit. Sand and gravel rose 5c. in Baltimore and 15c. to 25c. per ton in Detroit. Ready-mixed concrete is up 25c. per cu. yd. in Detroit, but off 25c. in New York.

Structural steel shapes are off 15c. per 100 lb. in Dallas, reinforcing bars are 10c. lower in Detroit, and metal lath is $2.50 per 100 sq. yd. lower in Detroit, for the only changes in iron and steel product prices.

Labor rates for both skilled and common labor remain unchanged from their October levels.

## CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

| | PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted | | | SAND AND GRAVEL Per ton, carload lots | | | CRUSHED STONE Per ton, carload lots | | CRUSHED SLAG Per ton, carload lots, f.o.b. plant | | CONCRETE Ready Mixed 1:2:4, 50 c.y. or more delivered |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cloth Bags *a* | Paper Bags | Bulk | Gravel, 1½ in. | Gravel, ¾ in. | Sand | 1½ in. | ¾ in. | 1½ in. | ¾ in. | |
| Atlanta | $2.90 | $2.66 | $2.61 | $1.75 | $1.85 | $1.95 | $1.65 | $1.75 | $1.55 | $1.65 | $7.90 |
| Baltimore | 2.31 | 2.06 | 1.86 | 1.75‡ | 1.75‡ | 1.25‡ | 1.75‡ | 1.75‡ | 1.75‡ | 1 75‡ | 6.75 |
| Birmingham | 2.50 | 2.25 | 2.05 | 1.75 | 1.75 | 1.50 | 1.00 | 1.00 | .90 | 1.15 | 5.80 |
| Boston | 2.75*b* | 2.50*b* | 2.30 | 1.20‡ | 1.20‡ | .90‡ | 1.20‡ | 1.20‡ | .... | .... | 6.75*m* |
| Chicago | 2.60 | 2.35 | 2.20 | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 2.00‡*d* | 1.25‡ | 1.25‡ | .... |
| Cincinnati | 2.58 | 2.33 | 2.08 | 1.20 | 1.20 | 1.10 | 1.80 | 1.80 | .... | .... | 6.60 |
| Cleveland | 2.00 | 1.75 | .... | 1.45*i* | 1.45*i* | 1.30*i* | 1.70*i* | 1.70*i* | 1.70*i* | 1.70*i* | 6.55*i* |
| Dallas | 2.47 | 2.22 | 2.02 | 1.75*p* | 2.00*p* | 1.25*p* | 1.69*p* | 1.84*p* | .... | .... | 6.20 |
| Denver | 3.02 | 2.77 | .... | 1.20 | 1.40 | .90 | .... | .... | .... | .... | 7.25 |
| Detroit | 2.53 | 2.28 | 2.08 | 1.55 | 1.65 | .95 | 1.55 | 1.65 | 1.25‡ | 1.35‡ | 6.75 |
| Kansas City | 2.56 | 2.31 | 2.16 | 1.85 | 2.30 | 1.00 | 1.91 | 1.91 | .... | .... | 7.25*n* |
| Los Angeles | 2.25*b* | 2.05*b* | .... | 1.00 | 1.00 | 1.00 | 1.00*f* | 1.00*f* | .... | .... | 5.85 |
| Minneapolis | 2.90 | 2.65 | .... | 1.00*h* | 1.00*h* | .25*h* | 1.00*h* | 1.00*h* | .... | .... | 7.35*j* |
| Montreal | .... | 1.82*r* | 1.67*r* | .... | .... | 1.25‡ | .85‡*c* | 1.00‡*c* | .... | .... | 6.45*l* |
| New Orleans | 2.41 | 2.16 | 1.96 | 1.50 | 1.50 | 1.25 | .... | .... | .... | .... | 7.25 |
| New York | 2.60‡ | 2.35‡ | .... | 1.25*de* | 1.25*de* | .75*de* | 1.65*de* | 1.75*de* | .... | .... | 6.50 |
| Philadelphia | 2.32 | 2.07 | 1.87 | 1.55‡ | 1.65‡ | 1.25‡ | .... | .... | 1.00 | 1.00 | 7.95*k* |
| Pittsburgh | 2.44 | 2.19 | 1.99 | 1.40‡ | 1.40‡ | 1.70‡ | 2.25‡ | 2.25‡ | 1.50 | 1.50 | 7.50 |
| St. Louis | 2.55 | 2.30 | .... | 1.50‡ | 1.50‡ | 1.25/1.50‡ | .90*h* | .90*h* | .75*g* | .75*g* | 7.50 |
| San Francisco | 2.16 | 1.96 | 1.66 | 1.36 | 1.36 | 1.36 | 1.46 | 1.46 | .... | .... | 6.95 |
| Seattle | 2.95*o* | 2.70*o* | .... | 1.00*o* | 1.00*o* | 1.00*o* | 2.00*o* | 2.00*o* | .... | .... | 7.25 |

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

### CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

| | Bagged | Bulk | | Bagged | Bulk | | Bagged | Bulk |
|---|---|---|---|---|---|---|---|---|
| Buffington, Ind. | $1.70 | $1.65 | Ironton, Ohio | $1.60 | $1.55 | Richard City, Tenn. | $1.80 | $1.75 |
| Dallas, Tex. (Inc. 5c. tax) | 1.80 | 1.75 | Limedale, Ind. | 1.70 | 1.65 | Steelton, Minn. | 1.80 | 1.75 |
| Hannibal, Mo. | 1.70 | 1.65 | Norfolk, Va. | 1.65 | 1.60 | Universal, Pa. | 1.65 | 1.60 |
| Hudson, N. Y. | 1.75 | 1.70 | Northampton, Pa. | 1.55 | 1.50 | Waco, Tex. (5c. tax in Tex.) | 1.75 | 1.70 |
| Independence, Kans. | 1.70 | 1.65 | North Birmingham, Ala. | 1.70 | 1.65 | Montreal | 1.55 | 1.55 |

## PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

| | PAVING BRICKS AND BLOCKS Granite per M. lots of 50.000 4x4x8 in. | Brick per M. 3x4x8½ in. carload lots | Wood per sq. yd. 3½ in. 16-lb. treat | PAVING ASPHALT Per ton, less than 80 penetration | | ASPHALT BINDERS—FLUXES Per gal., 80 300 penetration | | CUTBACK ASPHALT Per ton | | ROAD OILS Per gal. | ASPHALT EMULSION (Quick-breaking) Per gal. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Tank car | Drums | Tank car | Drums | Tank car | Drums | Tank car | Tank car | Drums |
| Atlanta | $73.00 | $39.35 | $2.25 | $17.30*e* | $23.83*e* | $0.0695*e* | $0.1018*e* | $0.0734*he* | $0.1257*h* | $0.0634*e* | $0.0734 | $0.1257 |
| Baltimore | 150.00‡ | 45.00‡ | 2.75 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | ...... | ...... | ...... |
| Birmingham | ...... | 27.50*j*‡ | .... | 18.20 | 23.20 | .0747 | .1047 | .0834*h* | .1484*h* | ...... | ...... | ...... |
| Boston | 90.00 | 47.50 | 3.25 | 14.00 | 20.00 | .06 | .09 | .065*h* | .115*h* | ...... | .09‡ | .12‡ |
| Chicago | 140.00 | 50.00 | 1.80*d* | 14.50 | 18.50 | 13.00*g* | 17.00*g* | .06*h* | .09*h* | .04 | .09 | 125 |
| Cincinnati | 112.00 | 37.50 | .... | 13.50 | 17.50 | .10 | ...... | 16.80 | ...... | .0525 | ...... | .075 |
| Cleveland | 110.00 | 37.50 | 2.80 | 15.50 | 20.50 | .065 | .075 | .075*h* | .085*h* | .0375 | .08 | .09 |
| Dallas | ...... | 30.00 | .... | 13.25 | 20.30 | .06 | .103 | 15.00 | 24.80 | .055 | .05/.07 | .07/.09 |
| Denver | ...... | 27.50 | .... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Detroit | ...... | 35.00 | .... | 13.15*f* | 18.45*f* | .061 | .0984 | 13.15 | 17.20 | .0475 | .061 | .0923 |
| Kansas City | ...... | 40.00 | .... | 18.50 | 23.50 | .077 | .1075 | .077*h* | .107*h* | .057 | .11 | .15 |
| Los Angeles | ...... | 50.00 | .... | 6.50*b* | 15.00 | 6.50*bg* | 15.00*bg* | 5.50*b* | ...... | .0192 | .0525 | .1125 |
| Minneapolis | ...... | ...... | 1.90*d* | 19.20 | 24.20 | .10 | .12 | 19.30 | 28.30 | .056 | ...... | ...... |
| Montreal | 75.00 | ...... | 3.62 | 14.60 | 21.25 | .105 | .137 | .101*h* | .121*h* | .07 | .135 | .185 |
| New Orleans | ...... | ...... | .... | 14.00*a* | 19.00*a* | .055 | .085 | .05*h* | .09*h* | ...... | .078 | ...... |
| New York | ...... | ...... | 2.80 | 15.00 | 21.00 | .06 | .09 | .065*h* | .115*h* | ...... | .07 | .11 |
| Philadelphia | 120.00 | 42.50 | 2.84 | 14.00 | 19.00 | .055 | .08 | .06*h* | .09*h* | .05 | .06 | .09 |
| Pittsburgh | 135.00 | 38.75 | .... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| St. Louis | 110.00/121.00 | 37.00 | .... | 14.00 | 19.00 | 14.00*g* | 19.00*g* | .06*h* | .095*h* | .04 | .09 | .125 |
| San Francisco | ...... | 70.00 | .... | 6.50 | 15.00 | 6.50*g* | 15.00*g* | 7.00 | 17.50 | .025 | .0525 | .1125 |
| Seattle | ...... | 60.00*c* | .... | 14.70 | 24.10 | ...... | 24.10*g* | 9.50/10.50 | 23.00/24.00 | 7.75*g* | .0575*i* | .1308*i* |

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

# DON'T WASTE TIME ON THE TURNS

Complete circle turn
Sharp Reverse turn
Right or left turn
Turn in any desired radius

## FULL SPEED AND POWER AHEAD—

Koehring does not need to "jockey", maneuver or make time-consuming, unnecessary moves to reach any section of the cut. Koehring travels the shortest way to the loading point. Turns are made directly . . . on grade or level . . . *saving time!* Tight places are no hindrance to a Koehring.

***Watch a Koehring move and see the difference.***

**KOEHRING CO • Milwaukee**

**1. Positive jaw-clutch on ends of shaft engage for full power application with friction clutch control.**

**2. Positive brakes, controlled by lever, on end of shaft hold one or *both* crawlers as required.**

KOEHRING HEAVY DUTY

**HEAVY-DUTY CONSTRUCTION EQUIPMENT**

## IRON AND STEEL PRODUCTS—BASE MILL PRICES

| | STRUCT. SHAPES-PLATE | REINF. BARS ¾-in. billet b | RIVETS ¾-in. structural | WIRE NAILS Base d | SHEET PILING Base | STEEL RAILS Per Gross Ton Standard | Light | Re-rolled | TRACK SUPPLIES Angle Bars | Std. Spikes c | Tie Plates c | Track Bolts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birmingham..... | $2.10 | $2.15 | $3.40 | $2.55 | ..... | $40.00 | $40.00 | $39.00 | $2.70 | $3.00 | $2.15 | $4.15 |
| Chicago......... | 2.10 | 2.15 | 3.40 | 2.55 | $2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Pittsburgh....... | 2.10 | 2.15 | 3.40 | 2.55 | 2.40 | 40.00 | 40.00 | 39.00 | 2.70 | 3.00 | 2.15 | 4.15 |
| Buffalo.......... | 2.10 | 2.15 | ..... | ..... | 2.40 | ..... | ..... | ..... | ..... | ..... | 2.15 | ..... |
| Cleveland........ | 2.10 | 2.15 | 3.40 | 2.55 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Youngstown..... | ..... | 2.15 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 3.00 | ..... | ..... |
| Detroit.......... | ..... | 2.25‡ | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Gulf ports....... | 2.45a | 2.40a | ..... | ..... | 2.85a | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Pacific ports..... | 2.75a | 2.50a | ..... | ..... | 2.95a | ..... | ..... | ..... | ..... | 3.00 | 2.30 | ..... |

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

## IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

| | STRUCTURAL SHAPES | REINFORCING BARS* Per 100 lb., ½ in., base price | | | | EXPANDED METAL LATH Per 100 sq.yd., carload lots | | WELDED FABRIC REINFORCING Per 100 s.f., carload lots | | | SHEET-PILING |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per 100 lb. base price | 15 tons or over b New billet | Rail steel | Add Switch | $/cwt. for Del. | Std. diamond mesh, 3.4 lb. | Std. ribbed 3.4 lb. | 4x16 in., No. 5 & 10 wires | 4x12 in., No. 8 & 12 wires | 6x6 in. No. 6 & 6 wires Per sq. yd. | Per 100 lb. base price |
| Atlanta.......... | $2.34 | $2.39 | $2.14 | .02½ | .10 | $21.00 | $23.00 | $1.82 | $1.35 | $0.1719 | $3.04 |
| Baltimore........ | 3.70 | 2.90 | 2.75 | ...... | .10 | 24.00 | 26.00 | 1.70 | 1.27 | .1611 | 2.90 |
| Birmingham..... | 2.10a | 2.15 | 2.15 | .02½ | .10 | 20.50 | 22.50 | 1.80 | 1.34 | .1701 | .... |
| Boston.......... | 3.85 | 2.61 | 2.46 | $20 C.L. | .10 | 21.50 | 23.50 | 1.76 | 1.31 | .1656 | 3.14 |
| Chicago.......... | 2.10a | 2.15 | 2.05 | .03 | .05 | 19.50 | 21.50 | 1.67 | 1.25 | .1575 | 2.40 |
| Cincinnati....... | 3.68 | 2.46c | 2.36c | ...... | .05 | 20.50 | 22.50 | 1.66 | 1.25 | .1566 | .... |
| Cleveland........ | 3.58g | 2.15 | 2.05 | .02½ | .10 | 22.50 | 23.50 | 1.66 | 1.25 | .1566 | .... |
| Dallas........... | 4.60 | 3.25 | 3.25 | ...... | ..... | 22.50 | 24.50 | 1.93 | 1.42 | .1827 | .... |
| Denver.......... | 4.35 | 3.95 | 3.80 | ...... | ..... | 23.50 | 25.50 | 1.97 | 1.45 | .1863 | .... |
| Detroit.......... | 3.60‡ | 2.25 | 2.15 | ...... | .10 | 22.50 | 24.50 | 1.68 | 1.26 | .1584 | 2.66 |
| Kansas City..... | 4.00 | 2.51c | 2.36c | .0 | .05 | 15.50 | 19.00 | 1.78 | 1.33 | .1683 | 2.86 |
| Los Angeles...... | 3.65f | 2.25 | 2.10 | .02½ | .05 | 23.00 | 27.50 | 1.93 | 1.42 | .1827 | 3.65 |
| Minneapolis...... | 3.80‡ | 2.48c | 2.33c | .0 | .10 | 19.50/20.50 | 21.50/22.50 | 1.80 | 1.34 | .1701 | 2.73d |
| Montreal........ | ...... | ...... | ...... | ...... | ..... | 26.50 | 29.00 | 2.99 | 2.08 | .319 | .... |
| New Orleans..... | 4.40 | 2.52 | 2.52 | .05 | .10 | 21.50 | 23.50 | 1.82 | 1.35 | .1719 | 2.875 |
| New York....... | 3.75 | 2.39 | 2.29 | ...... | .10 | 14.50 | 16.50 | 1.76 | 1.32 | .1665 | 2.74 |
| Philadelphia..... | 3.55 | 2.66 | 2.56 | ...... | ...... | 19.50 | 21.50 | 1.71 | 1.28 | .1611 | 2.72 |
| Pittsburgh....... | 2.10a | 2.15 | 2.05 | .02½ | .10 | 21.50 | 24.50 | 1.59 | 1.20 | .1503 | 2.40 |
| St. Louis........ | 3.47 | 2.39 | 2.29 | .0 | .05 | 24.00 | 28.00 | 1.69 | 1.27 | .1602 | 2.70 |
| San Francisco.... | 3.35 | 2.40 | 2.25 | .02½ | .10 | 19.00 | 25.50 | 1.93 | 1.42 | .1827 | 3.25 |
| Seattle.......... | 2.75e | 2.50e | ...... | ...... | ...... | 25.50 | 27.50 | 1.93 | 1.42 | .1827 | 2.95e |

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

## PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

| | C. I. PIPE | VITRIFIED SEWER PIPE | | | | CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. | | CONCRETE SEWER PIPE Per ft., delivered; | | WROUGHT STEEL PIPE Full standard weight, h 1 to 3 in., Butt Weld | | 3½ to 6 in.; Lap Weld | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Per net ton f.o.b. 6 in. to 24 in. a | Per foot, std. 8 in., s.s. | delivered std. 12 in., s.s. | ASTM 24 in., | C13–35 36 in., | 6 in. | 8 in. | ASTM 12 in. | C 14–35 24 in. | Black % | Galv. % | Black % | Galv. % |
| Atlanta........ | $49 40 | $0.26b | $0.468bc | $1.8525 | $4.68c | $85.00 | $128.00 | $0.45 | $1.642 | 62.2 | 54.2 | 59.7 | 51.2 |
| Baltimore...... | 52.80 | .35 | .60 | 2.30 | 6.80 | 115.00 | 150.00 | .50 | 1.75 | 65.5 | 57.5 | 63.00 | 54.5 |
| Birmingham... | 45.00 | .26 | .468 | 1.7875 | 4.66 | 85.00 | 220.00 | .40 | 1.60 | 62.2 | 54.2 | 59.7 | 51.2 |
| Boston......... | 55.00 | .231 | .4455 | 1.89 | 5.2275 | 180.00‡ | 280.00‡ | .50 | 2.30 | 64.1 | 56.1 | 61.6 | 53.1 |
| Chicago........ | 53.80 | .28 | .54 | 2.25 | 6.25 | 100.00‡ | 150.00‡ | .38 | 1.48 | 67.0 | 59.0 | 63.5 | 55.0 |
| Cincinnati..... | 52.70 | .245 | .4995 | 1.9335 | 5.6375 | 105.00 | 170.00 | .60 | 1.70 | 65.9 | 57.9 | 63.4 | 54.9 |
| Cleveland...... | 54.24 | .196 | .378 | 1.485 | 4.51 | 69.00 | 108.00 | .35 | 1.50 | 67.8 | 59.8 | 65.3 | 56.8 |
| Dallas......... | 58.20 | .28 | .504 | 2.016 | 4.70 | 80.00 | 100.00 | .46 | 1.57 | 59.9 | 51.9 | 57.3 | 48.3 |
| Denver........ | 60.60 | .24† | .52f | 2.16† | ...... | 130.00 | 240.00 | .... | .... | 58.4 | 50.4 | 55.7 | 47.2 |
| Detroit........ | 54.24 | .245 | .4725 | 1.935 | 4.408 | 66.45 | 105.00 | .33 | 1.50 | 66.3 | 58.3 | 63.8 | 55.3 |
| Kansas City... | 55.12 | .30 | .54 | 2.16 | 5.00 | 120.00 | 240.00 | .45 | 1.60 | 62.9 | 54.9 | 60.0 | 51.5 |
| Los Angeles.... | 55.00 | .282† | .508† | 2.034† | 5.085† | 115.50 | 192.50 | 1.00 | 2.00 | 59.6 | 51.6 | 57.0 | 48.6 |
| Minneapolis.... | 57.20 | .24† | .432† | 1.728† | 4.60† | ...... | ...... | .70 | 1.80 | 64.2 | 56.2 | 60.7 | 52.2 |
| Montreal...... | 60.00 | .55 | .90 | 3.68 | 5.95e | 135.00‡ | 260.00‡ | .48 | 1.92 | ...... | ...... | ...... | .... |
| New Orleans... | 51.38 | .26 | .48 | 1.69 | ...... | 150.00 | 220.00 | .37 | 2.10 | 62.4 | 54.4 | 58.8 | 50.3 |
| New York..... | 52.20 | .32 | .63 | 2.52 | 6.45 | ...... | ...... | .50 | 1.20 | 64.9 | 56.8 | 62.4 | 53.9 |
| Philadelphia... | 50.90 | ...... | ...... | ...... | ...... | ...... | ...... | .54 | 1.80 | 65.3 | 57.3 | 62.8 | 54.3 |
| Pittsburgh..... | 55.60 | .245† | .4725† | 1.845† | 5.4325 | 97.80 | 154.20 | .85g | 2.00g | 68.5i | 60.5i | 66.0i | 57.5i |
| St. Louis...... | 52.48 | .24 | .432 | 1.728 | 3.96 | 85.00 | 170.00 | .75j | 1.80k | 65.1 | 57.1 | 62.0 | 53.5 |
| San Francisco.. | 55.00 | .3275c | .5895d | 2.358 | 5.895 | 107.25 | 178.75 | .54 | 2.50 | ...... | ...... | ...... | .... |
| Seattle........ | 55.35 | .35 | .63 | 2.52 | 6.30 | 72.00 | 175.00 | .35f | 1.30f | ...... | ...... | ...... | .... |

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest ptice at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

HERE'S THE REASON

*Timber*

# IS MAKING ENGINEERING HISTORY

TIMBERS joined by TECO Connectors will do more work than timbers joined the old way—with many bolts, plates and angles . . . *Frequently a single 2½" TECO split ring connector will carry more load than six one-half inch bolts.*

Timber construction, fundamentally our lowest cost means of doing heavy work, can now be employed for a wide variety of new applications.

The connector system has revised traditional formulas for designing in timber . . . changed it from a carpentry to an engineering material and stimulated the establishment of widespread new capacity for shop fabrication.

TECO Connectors spread the load on a timber joint over practically the entire cross section of the wood. In bolted joints this stress is localized around the bolt.

**WOULD YOU LIKE TO KNOW HOW**
nearly 30,000 new structures—hangars, bridges, trestles, dry docks, barracks, trusses, towers and oil derricks—have saved money by employing low-cost TECO-equipped lumber construction?

HAVE YOU FULL, DETAILED INFORMATION ON THE TECO CONNECTOR SYSTEM? WRITE TODAY. USE THE COUPON BELOW.

## *Timber* ENGINEERING COMPANY INC.

Dept. L-11 1337 Connecticut Avenue
WASHINGTON, D. C.

TIMBER ENGINEERING COMPANY, Inc., Dept. L-11
1337 Connecticut Avenue, Washington, D. C.

Please send us full technical information on the new design opportunities in timber made possible through the development of the Teco Connector system.

Individual ..............................................................
Firm ..............................................................
Street ..............................................................
City .............................................. State..................

## LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

| | SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common. Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)* | | | | | | | | | LONG LEAF Y. P. Merchantable grade up to 20 ft. | | PLYWOOD* Rail freight increment (See note for base price) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1x6 S4S | 1x8 S4S | 2x4 S4S | 2x6 S4S | 2x8 S4S | 2x10 S4S | 3x12 Rgh | 6x12 Rgh | 12x12 Rgh | 2x12 Rgh | 12x12 Rgh | ⅝" | ¾" |
| Atlanta | **$32.00** | **$32.00** | **$27.00** | **$28.50** | **$28.50** | **$32.00** | **$34.50** | ...... | ...... | $47.00 | $57.00 | $17.75 | $21.60 |
| Baltimore | **35.00** | **36.50** | **36.00** | **37.00** | **37.00** | **38.00** | **50.00** | ...... | ...... | 72.00 | 74.00 | 17.35*g* | 21.15*g* |
| | *37.00* | *37.00* | *39.00* | *38.00* | *38.00* | *37.00* | *50.00* | *$50.00* | *$50.00* | ...... | ...... | ...... | ...... |
| Birmingham | **34.00** | **34.00** | **32.00** | **32.00** | **32.00** | **33.00** | **40.00** | **40.00** | **40.00** | ...... | ...... | 16.25 | 19.85 |
| [1] | 38.00 | 38.00 | 37.00 | 37.00 | 38.00 | 38.00 | 58.00 | ...... | ...... | 55.00 | 51.00 | ...... | ...... |
| Boston | 33.00[2] | 33.00[2] | 36.00[3] | 36.00 | 55.00[1] | 60.00[1] | 77.00[1] | ...... | ...... | 77.00 | 77.00 | 17.35*g* | 21.15*g* |
| | *32.00* | *32.00* | *36.00* | *36.00* | *38.00* | *38.00* | *47.00* | *47.00* | *47.00* | ...... | ...... | ...... | ...... |
| Chicago | **41.00** | **41.00** | **38.00** | **37.00** | **37.00** | **42.00** | **52.00** | ...... | ...... | 90.00 | 100.00 | 13.80 | 16.80 |
| | *39.00* | *40.00* | *40.00* | *40.00* | *40.00* | *41.00* | *45.00* | *45.00* | *45.00* | ...... | ...... | ...... | ...... |
| Cincinnati | **31.50** | **33.00** | **30.50** | **31.00** | **32.00** | **35.00** | **44.50** | ...... | ...... | 53.00 | 56.00 | 16.25 | 19.85 |
| | ...... | ...... | ...... | ...... | ...... | ...... | *46.00* | *46.00* | *46.00* | ...... | ...... | ...... | ...... |
| Cleveland | **38.50** | **40.00** | **40.00** | **38.00** | **36.00** | **42.00** | **49.00** | **49.00** | **49.50** | 82.50 | 82.50 | 16.70 | 20.40 |
| Dallas *e* | **36.00** | **39.00** | **37.00** | **36.00** | **37.00** | **37.50** | **52.50** | **52.50** | **52.50** | 74.00 | 81 00 | 13.90 | 16.95 |
| Denver ‡ | 45.00[4] | 43.00[4] | 47.00[4] | 46.00[4] | 46.00[4] | 48.00[4] | 48.00[4] | 58.00[4] | 65.00[4] | ...... | ...... | 9.90 | 12.05 |
| Detroit | **42.00** | **42.00** | **40.00** | **42.00** | **42.00** | **44.00** | **51.00** | ...... | ...... | 50.00 | 59.00 | 16.25 | 19.85 |
| | ...... | ...... | ...... | ...... | ...... | *49.00* | *52.00* | *59.00* | *59.00* | ...... | ...... | ...... | ...... |
| Kansas City | **40.00** | **41.00** | **37.50** | **37.50** | **37.00** | **37.50** | **40.00** | ...... | ...... | 65.00 | 70.00 | 12.25 | 14.95 |
| | *37.50* | *37.50* | *38.50* | *38.00* | *38.00* | *37.50* | *40.00* | *43.00* | *43.00* | ...... | ...... | ...... | ...... |
| Los Angeles *a* | *40.00* | *40.00* | *39.00* | *39.00* | *36.00* | *36.00* | *43.00* | *48.00* | *43.00* | ...... | ...... | 9.35*gh* | 11.35*gh* |
| Minneapolis ‡*b* | 40.00[8] | 40.00[8] | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 12.05 | 14.70 |
| ‡ | *42.00* | *42.00* | *42.00* | *40.00* | *40.00* | *42.00* | *44.50* | *53.50* | *53.50* | ...... | ...... | ...... | ...... |
| Montreal †[7] | *34.00* | *36.00* | *32.00* | *34.00* | *36.00* | 42.00 | 45.00 | ...... | ...... | 155.00 | 165.00 | ...... | ...... |
| | *52.00* | *54.00* | *52.75* | *55.75* | *57.75* | *60.75* | *52.00* | *52:00* | *52.00* | ...... | ...... | ...... | ...... |
| New Orleans | **24.00** | **25.00** | **25.00** | **24.00** | **24.00** | **25.00** | **46.00** | ...... | ...... | 62.00 | 69.00 | 13.90 | 16.95 |
| | *29.00* | *29.00* | *32.00* | *33.00* | *35.00* | *34.00* | *36.00* | ...... | ...... | ...... | ...... | ...... | ...... |
| New York ‡ | 47.00 | 48.00 | **42.00** | **44.00** | **44.00** | **45.00** | **47.00** | ...... | ...... | 82.50*f* | 85.00*f* | 17.35*g* | 21.15*g* |
| ‡ | ...... | ...... | *47.00* | *47.00* | *47.00* | *47.00* | *47.00* | *51.00* | *51.00* | ...... | ...... | ...... | ...... |
| Philadelphia | **24.00** | **24.50** | **25.50** | **25.50** | **27.50** | **27.50** | **29.00** | ...... | ...... | 50.00 | 57.50 | 17.35*g* | ..1512*g* |
| | *35.00* | *36.50* | *39.00* | *38.25* | *29.00* | *39.00* | *44.00* | *32.00* | *32.00* | ...... | ...... | ...... | ...... |
| Pittsburgh | **38.10** | **39.90** | **47.05** | **42.00** | **45.65** | **46.90** | **59.70** | ...... | ...... | ...... | ...... | 17.00 | 20.70 |
| | *51.90* | *49.60* | *49.60* | *49.00* | *48.90* | *49.25* | *66.55* | *66.55* | *66.55* | ...... | ...... | ...... | ...... |
| St. Louis ‡*c* | **41.00** | **41.00** | **37.00** | **36.00** | **37.00** | **38.00** | **49.00** | *57.00* | *57.00* | 75.00 | 74.00 | 13.90 | 16.95 |
| San Francisco *d* | *28.00* | *27.00* | *28.00* | *29.50* | *29.00* | *29.50* | *29.50* | *28.00* | *28.00* | ...... | ...... | 7.30*g* | 8.90*g* |
| Seattle | *23.00* | *23.00* | *23.00* | *23.00* | *23.00* | *23.00* | *29.00* | *29.00* | *29.00* | ...... | ...... | 0.00 | 0.00 |

**Bold Face type, Southern Pine.** *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft. † Montreal prices stabilized for balance of year by order of Dominion Controller of Lumber.

NOTE: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅝", $81.60; on ¾", $89.90; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *Many mills out of market due to rush of defense orders. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

## GLASS, EXPLOSIVES, CHEMICALS

| | WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality | B quality | EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots* |
|---|---|---|---|
| Atlanta | 75% | 75% | $0.15 |
| Baltimore | 83% | 82% | .15 |
| Birmingham | 75% | 75% | .105 |
| Boston | 82% | 82% | .15 |
| Chicago | 79% | 79% | .15 |
| Cincinnati | 77% | 77% | .15 |
| Cleveland | 79–10–10% | 79–10–10% | .205 |
| Dallas | 78% | 78% | .165 |
| Denver | 77% | 77% | .15*e* |
| Detroit | 79–10% | 79–10% | .15 |
| Kansas City | 77–10% | 77–10% | .165 |
| Los Angeles | 86%*d* | 88%*d* | .1575 |
| Minneapolis | 76% | 76% | .16 |
| Montreal | ...... | ...... | .17† |
| New Orleans | 70% | 75% | .16 |
| New York | 81% | 82% | .22*f* |
| Philadelphia | 82–10%*d* | 83–10%*d* | .15 |
| Pittsburgh | 79% | 79% | .1425 |
| St. Louis | 77–10% | 77–10% | .155 |
| San Francisco | 78%*d* | 83%*d* | .155 |
| Seattle | 85%*d* | 88%*d* | .1575 |

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

*a* Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

**40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)**

| | C/L 20,000 lb. net | Tons | 200 lb. lots |
|---|---|---|---|
| E. of the Miss., except Fla | $0.105 | $0.14 | $0.16 |
| W. of Miss. to Rocky Mtn. States, and Fla | .11 –.12 | .135 –.15 | .155 –.17 |
| Rocky Mtn. States | .11 –.1325 | .13 –.145** | .15 –.165** |
| Pacific N. W. States | .1075–.115 | .1375–.15 | .1575–.17 |
| Pacific S. W. States | .1050–.1175 | .135 –.1475 | .155 –.1625 |

** F.o.b. Louviers, Colo., or Butte, Mont.

## PILES, TIES—F.O.B.

### PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

| Dimensions | Points | Length | Short Leaf Barge | Short Leaf Rail |
|---|---|---|---|---|
| 12 in. at butt | 6 in. | 30 to 50 ft. | $0.18 | $0.195 |
| 12 in.— 2 ft. from butt | 6 in. | 50 to 59 ft. | .225 | .24 |
| 12 in.— 2 ft. from butt | 6 in. | 60 to 69 ft. | .23 | .255 |
| 14 in.— 2 ft. from butt | 6 in. | 50 to 69 ft. | .24 | .265 |
| 14 in.— 2 ft. from butt | 6 in. | 70 to 79 ft. | .28 | .275 |
| 14 in.— 2 ft. from butt | 5 in. | 80 to 85 ft. | .40 | .415 |
| 14 in.— 2 ft. from butt | 5 in. | 85 to 89 ft. | .42 | .482 |

### RAILWAY TIES

| Prices f.o.b., per tie for carload lots: | | 6"x8"x8′ Untr. | 6"x8"x8′ Tr. | 7"x9"x8′6" Untr. | 7"x9"x8′6" Tr. |
|---|---|---|---|---|---|
| Boston | Oak | $1.20 | .... | $1.65 | .... |
| | Pine | 1.50 | $2.25*a* | 2.25 | $3.20*a* |
| New York | S. L. Sap Pine | 1.20/1.30 | 1.95 | 1.60 | 2.45 |
| | Mixed Oak | 1.55 | 2.05 | 2.00 | 2.55 |
| Birmingham | White Oak | .85 | 1.50*a* | 1.35 | 1.70*a* |
| | Southern Pine | .55*b* | 1.10*ab* | .70 | 1.30*a* |
| Chicago | Oak | .... | 1.65*a* | .... | 2.25*a* |
| | Southern Pine | .... | 1.53*a* | .... | 2.13*a* |
| Los Angeles | Douglas Fir | .64 | 1.38*a* | .90 | 1.80*a* |
| Philadelphia | Red Oak | 1.10 | .... | .... | 2.40*a* |
| St. Louis | White Oak | 1.12 | .... | 1.50 | .... |
| | Red Oak | 1.12 | 1.60*a* | 1.50 | 2.05*a* |
| | Sap Pine or Cypress | 1.02 | .... | 1.40 | .... |
| San Francisco | Douglas Fir | 1.00*bef* | .... | .... | 2.45*caf* |
| Montreal | Birch or Maple | .65 | 1.05*a* | .75 | 1.35*a* |

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8′6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

### CHEMICALS

**Water, sewage treatment, road work, f.o.b. carlots, New York**

| | |
|---|---|
| Bleaching powder, in drums, f.o.b. works, per 100-lb | $2.00-2.85 |
| Chlorine cylinders, liquid, per lb. delivered | .0525 |
| Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton | 20 50-35.00 |
| Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb | 1.40 |
| Soda ash, 58%, in paper bags, per 100 lb. dense | 1.10 |
| Sulphate of aluminum, commercial, in 100-lb. bags, per ton | 23.00 |
| Sulphate of copper, in bbl., per 100-lb | 4.75 |

# FOR A LASTING PAINT JOB ON STEEL

Flame cleaning and dehydrating a "99" road grader frame in the Aurora, Illinois, plant of the Austin-Western Co. A saving of 80¢ per frame has been effected here by using the Airco process.

AIRCO

**FLAME CLEAN and DEHYDRATE**

*Before you paint*

Moisture and loose millscale is removed from the surface of the steel, and provides, after wire brushing, a surface conducive to a lasting paint job. Danger of under paint surface failure is minimized. The apparatus used in the process is standard, portable and flexible. It can be operated by available personnel and is safe and simple.

Now is the time to avoid the usual worry and expense that repainting steel frequently involves when steel is not properly surface-conditioned prior to initial primer painting. Write us your problem and the members of our engineering department will be glad to give you the most workable solution.

## AIR REDUCTION

***General Offices:*** **60 EAST 42nd ST., NEW YORK, N. Y.**

**DISTRICT OFFICES IN PRINCIPAL CITIES**

AIRCO [illegible] for GAS WELDING or CUTTING and ARC WELDING WILSON

# STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

| | STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over, | | | STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over, | | | BRICK Per M. in quantity. | | LIME | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3x12x12 in. | 4x12x12 in. | 8x12x12 in. | 8x12x12 in. | 10x12x12 in. | 12x12x12 in. | Common backing | Straight hard | Per ton, Hydrated finishing | In paper, Common hydrated | Carload lot, Pulverized or lump |
| Atlanta | $90.00 | $100.00 | $185.00 | $220.00 | $230.00 | $240.00 | $12.50 | $16.00 | $26.50 | $17.00 | $17.00 |
| Baltimore | 75.00 | 80.00 | 150.00 | 180.00 | 225.00 | 280.00 | 14.00*k* | 17.00*k* | 18.50 | 15.00 | 2.50*m* |
| Birmingham | 80.00 | 85.00 | 160.00 | 191.00 | 252.00 | 288.00 | 13.50 | 16.50 | 18.11 | 12.64 | 1.66*o* |
| Boston | 95.05*a* | 101.40*a* | 190.05*a* | 215.35 | 279.20*a* | 319.10*a* | 17.00*i* | 20.00*i* | 21.00 | 14.00 | 18.00*l* |
| Chicago | 68.10 | 72.60 | 135.90 | 185.70 | 234.90 | 268.10 | 11.00 | 12.00 | 16.40 | 14.40 | 12.20 |
| Cincinnati | 61.40 | 65.30 | 121.90 | 141.50 | 187.30 | 215.20 | 16.00 | 16.00 | 15.90 | 13.00 | ..... |
| Cleveland | 56.50 | 60.00 | 112.50 | 135.00 | 182.50 | 209.00 | 16.00 | 16.00 | 15.00*j* | 12.00*j* | 2.75*jm* |
| Dallas | 62.50 | 67.00 | 135.00 | 162.00 | 177.00 | 263.00 | 11.50*i* | 13.50*i* | 19.00 | 15.00 | .95*n* |
| Denver | 84.80 | 95.40 | 152.70 | 178.20 | 212.00 | 227.90 | 13.50 | 17.00 | 28.00*j* | 17.00*j* | 35.00*j* |
| Detroit | 69.00 | 73.60 | 138.00 | 176.00 | 232.00 | 265.00*e* | 16.00 | 17.00 | 13.50 | 11.75 | 12.75 |
| Kansas City | 64.50 | 66.50 | 86.00*c* | 125.50 | 159.75 | 186.25 | 14.25 | 24.00 | 19.10 | 12.80 | 10.70 |
| Los Angeles | 73.50†*r* | 89.50†*r* | 128.00*c*†*r* | 210.00†*r* | 368.00†*r* | 460.00†*r* | 13.50 | 15.00 | 16.50 | ...... | 17.50 |
| Minneapolis | 71.45 | 76.20 | 143.95 | 171.45 | 173.80 | 242.10 | 13.10 | 15.10*g* | 21.00 | 16.00 | 19.00 |
| Montreal | 72.20*a* | 77.50*a* | 142.50*a* | 76.00*at* | 165.80*a* | 248.70 | 20.75 | 28.00 | 23.50 | 17.00 | 12.00 |
| New Orleans | 72.00 | 72.00 | 135.00 | 162.00 | 210.00 | 260.00 | 14.00 | ...... | 18.30 | 12.08 | 14.10 |
| New York | 87.00 | 93.00 | 128.00*c* | 193.30*h* | 238.80*h* | 295.60*h* | 13.00 | ...... | 19.00 | 14.00 | 17.00 |
| Philadelphia | 80.50 | 85.90 | 161.10 | 193.30 | 238.80 | 295.60 | 15.50*s* | 18.00*s* | 15.50*q* | 9.55*q* | 12.05*q* |
| Pittsburgh | 58.40 | 62.40 | 116.85 | 124.00 | 153.00 | 193.75 | 17.00 | 25.00 | 17.90 | 15.40 | 2.55*m* |
| St. Louis | 62.00 | 88.00 | 120.00 | 180.00 | 234.00 | 280.00 | 16.00 | 17.00 | 22.00 | 16.00 | 2.30*lm* |
| San Francisco | 84.00 | 94.50 | 225.00 | ...... | ...... | ...... | 14.00 | 17.00 | .55*o* | .40*o* | 2.05*m* |
| Seattle | 100.00 | 110.00 | 220.00 | ...... | ...... | ...... | 17.50*f* | 17.50*f* | 20.00*s* | 20.00*s* | 20.00*s* |

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c. per M. off for cash.

*j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

# PAINT, ROOFING—F.O.B. CARLOAD LOTS

| | RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl. | WHITE LEAD | READY-MIXED PAINT Per gal., drums | | | ROOFING SUPPLIES Carload lots f.o.b. factory | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dry *a* | Per 100 lb. in oil | Graphite *b* | Aluminum *c* | Ferric Oxide *d* | Rolls, slate surfaced, 85-90 lb. per sq. | Asphalt felt, per 100 lb. | Tar felt, per 100 lb. | Asphalt coating per gal. | Tar pitch 350 lb. bbl. per ton |
| Atlanta | $9.25 | $13.125 | $1.30 | $2.25 | $1.20 | $1.90 | $1.61 | $1.61 | $0.27 | $29.00 |
| Baltimore | 9.00 | 12.75 | 1.75 | 2.50 | 2.00 | 2.25 | 2.85 | 2.85 | .50 | 27.50 |
| Birmingham | 9.25 | 13.125 | 2.35 | 2.75 | 1.85 | 1.98 | 1.57 | 1.57 | .32 | 27.00 |
| Boston | 9.00 | 12.75 | 1.85‡ | 2.50‡ | 1.80‡ | 1.80‡ | 1.85*h*‡ | 1.85*h*‡ | .50‡ | 20.00‡ |
| Chicago | 9.00 | 12.75 | 1.96 | 2.63 | 1.68 | 1.45*hf* | 1.50*hf* | 1.50*hf* | .25*f* | 21.00*f* |
| Cincinnati | 9.00 | 12.75 | 1.65 | 2.85 | 1.55 | 2.40 | 2.39*h* | 2.39*h* | .36 | 21.00 |
| Cleveland | 9.00 | 12.75 | 1.90 | 2.60 | 1.60 | 1.75 | 1.50*h* | 1.50*h* | .35 | 21.00 |
| Dallas | 9.00 | 13.50 | 1.88 | 2.11 | .... | 2.75*h* | 2.60*h* | 2.70*h* | .275 | 34.00 |
| Denver | 9.50 | 13.25 | 1.65 | 2.40 | .17*l* | 2.45 | 4.00 | 3.00 | .35 | 18.00 |
| Detroit | 9.00 | 12.75 | 1.75 | 2.75 | 1.25 | 2.40 | 2.50 | 2.50 | .35 | 26.00 |
| Kansas City | 9.00 | 12.875 | 2.15*g* | 2.40*g* | 1.67*g* | 1.93 | 2.09 | 2.09 | .25 | 25.00 |
| Los Angeles | 9.25 | 13.25 | 1.60 | 2.25 | 2.30 | 2.10 | 1.50 | .... | .45 | ..... |
| Minneapolis | 9.00 | 12.875 | .... | .... | .... | 1.75*i* | 1.50*hi* | 1.50*hi* | .29 | 21.00 |
| Montreal | 9.25 | 9.00 | 2.25 | 2.80 | 2.35 | 2.53 | 1.68 | 1.78 | .70 | 1.68*k* |
| New York | 9.00 | 12.75 | 1.88 | 2.55 | 1.60 | 1.75 | 1.50*h* | 1.50*h* | .23 | 24.00 |
| Philadelphia | 9.00 | 12.75 | .... | .... | .... | 1.92*e* | 1.99*he* | 1.99*he* | .41*e* | 21.00 |
| Pittsburgh | 9.00 | 12.75 | 1.05 | 1.95 | .80 | 1.95 | 1.94*h* | 1.94*h* | .34 | 26.00 |
| St. Louis | 9.00 | 12.75 | 1.90/2.00 | 2.60/2.80 | 1.60/2.00 | 2.04 | 1.50 | 1.50 | .24 | 21.00 |
| San Francisco | 9.25 | 13.00 | 1.80 | 2.75 | 1.10/2.00 | 1.65 | 2.26 | 2.26 | .28 | 17.00 |
| Seattle | 9.25 | 13.25 | 1.80 | 2.60 | .... | 1.81 | 1.30/2.00 | 1.75 | .35 | 28.00*j* |

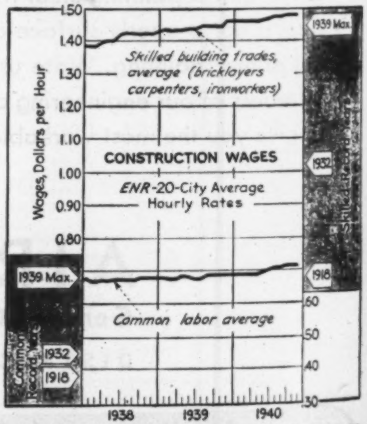
‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide.

*e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb.

# SKILLED AND COMMON WAGE RATES—PER HOUR

| | Bricklayers | Carpenters | Struct. Iron Workers | Hoisting Engineers | Plasterers | Common Labor Building | Common Labor Heavy Const. |
|---|---|---|---|---|---|---|---|
| Atlanta | $1.25 | $1.00 | $1.375 | $1.00/1.25 | $1.25 | $0.40/.50 | $0.40/.50 |
| Baltimore | 1.50 | 1.25 | 1.65 | 1.50 | 1.375 | .625 | .625 |
| Birmingham | 1.50 | 1.125 | 1.375 | 1.125 | 1.00 | .40 | .40 |
| Boston | 1.50 | 1.375 | 1.625 | 1.375/1.625 | 1.625 | .60/.85 | .60/.85 |
| Chicago | 1.70 | 1.625 | 1.70 | 1.70 | 1.70 | 1.025 | 1.025 |
| Cincinnati | 1.625 | 1.45 | 1.55 | 1.375/1.525 | 1.625 | .75 | .75 |
| Cleveland | 1.625 | 1.375 | 1.50 | 1.50/1.75 | 1.50 | .90 | .90 |
| Dallas | 1.50 | 1.00 | 1.25 | 1.00 | 1.50 | .40/.50 | .40/.50 |
| Denver | 1.65*b* | 1.43*b* | 1.43*b* | 1.43*b* | 1.50*b* | .718*b* | .718*b* |
| Detroit | 1.50 | 1.25 | 1.625 | 1.50 | 1.55 | .60/.75 | .60/.775 |
| Kansas City | 1.625 | 1.375 | 1.50 | 1.50 | 1.575 | .85 | .50 |
| Los Angeles | 1.25 | 1.10 | 1.375 | 1.375 | 1.50 | .625 | .625 |
| Minneapolis | 1.375 | 1.25*d* | 1.50 | 1.40 | 1.50*e* | .85 | .85 |
| New Orleans | 1.50 | 1.25 | 1.375 | 1.375 | 1.40 | .40 | .50 |
| New York | 2.00*b* | 1.85*b* | 2.00 | 2.00*b* | 2.00*c* | 1.031 | .875/.95 |
| Philadelphia | 1.65*b* | 1.40 | 1.65 | 1.50 | 1.75 | .70 | .70 |
| Pittsburgh | 1.75 | 1.50 | 1.50 | 1.25 | 1.75 | .80 | .70 |
| St. Louis | 1.50 | 1.50 | 1.75 | 1.50/2.00 | 1.75 | .45/.875 | .875 |
| San Francisco | 1.75*c* | 1.25 | 1.60 | 1.50 | 1.60*c* | .813 | .813 |
| Seattle | 1.60 | 1.25 | 1.50 | 1.50 | 1.60 | .90 | .90 |
| Montreal | .80 | .70 | .75 | .65 | .80 | .45 | .40 |

*b* 7 hr. day. *c* 6 hr. day *d* 35 hr. wk. *e* 30 hr. wk.



**ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.480**
**ENR Common Average: $0.711**